ELECTRICITY

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ELECTRICITY

BY

W. E. STEAVENSON, M.D.

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ELECTRICITY

AND ITS MANNER OF WORKING IN THE TREATMENT OF DISEASE

A THESIS

FOR THE

M.D. DEGREE OF THE UNIVERSITY OF CAMBRIDGE

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TO WHICH IS APPENDED

AN INAUGURAL MEDICAL DISSERTATION ON

ELECTRICITY

FOR THE

DEGREE OF DOCTOR OF MEDICINE OF THE UNIVERSITY OF EDINBURGH

WRITTEN IN LATIN BY

DR ROBERT STEAVENSON
1778

WITH A TRANSLATION BY THE

REV. FREDERICK ROBERT STEAVENSON, M.A.
OF COLESBORNE, GLOUCESTERSHIRE
LATE CLASSICAL SCHOLAR OF EMMANUEL COLLEGE, CAMBRIDGE

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TO MY BROTHER

JOSEPH LEWIS STEAVENSON

OF SHANTOCK HALL, BOVINGDON, HERTS.
CAPTAIN 1ST BATTALION ROYAL IRISH FUSILIERS
(LATE 87TH REGIMENT)

AND TO THE

REV. ROBERT STEAVENSON

OF NEWTON HALL, STOCKSFIELD-ON-TYNE
GRANDSON OF THE LATE DR ROBERT STEAVENSON

W. E. STEAVENSON.

ELECTRICITY

AND ITS

MANNER OF WORKING IN THE TREATMENT OF DISEASE

I HAVE taken as a model for this thesis one written more than a hundred years ago by an ancestor for the M.D. degree of the University of Edinburgh.* I have adopted the same title, and will endeavour to show the advance made in the application of electricity to medicine during the past century. The thesis to which I refer was one of the earliest dissertations upon medical electricity written by an Englishman, and at the time was a work of much repute. The whole science of electricity in its application to medicine has now changed. At the time when Dr Robert Steavenson wrote only statical electricity was

* 'Dissertatio Medica Inauguralis, de Electricitate et Operatione ejus in Morbis Curandis.' Robertus Steavenson, A.M. Britannus; Edinburgi, MDCCLXXVIII.

known. Eight years later Galvani made his wonderful discovery of the presence or production of electric currents in the nerves of a frog,* and five years later still† made his discovery known. This gave rise to the origin of galvanism. Forty years‡ after this our great philosopher Faraday discovered the secret of induction, which gave rise to what is now called faradism. These two forms of electricity are those which are now most frequently employed in the treatment of disease.

The little advance we have made in the application of electricity to medicine is due to a variety of causes, but chiefly to the expense and cumbersomeness of the necessary apparatus, the difficulties connected with its administration, and the disrepute into which the science has fallen by the use made of it by unscrupulous and ignorant men. More quackery has gone on under the names of electricity, odic force, animal magnetism, and similar phrases than perhaps in any other department of medicine. The reason is that electricity is a most powerful agent, and is known to do good both by those who profess to a knowledge of its action and by those who have sought relief by its agency. The professors of the art have generally been ignorant of its mode

* 1786. † 1791. ‡ 1831.

of action and unable or unwilling to distinguish the cases in which it should be used or the reverse, and have exaggerated its marvellous and all-healing powers for their own pecuniary advantage. Ignorance of the mode of action of electricity would be excusable if acknowledged, for we are still ignorant of the cause of many of the effects it produces, but one of the characteristics of the ignorant impostor is the glibness with which he explains and attempts to demonstrate the mode of action.

The former electrical treatment was of course purely empirical, a mere matter of chance, and intelligent medical and scientific men, appreciating this, and knowing of no laws or principles upon which the treatment could be applied, ignored its use entirely; and the knowledge of many of the wonderful effects derived by treatment with electricity a hundred years ago has now faded into oblivion and is unknown to the practitioner of the present day. But the art has been practised and preserved by quacks with the result of much imposition on the public.

The latest accepted theory concerning the nature of sound, heat, light, and electricity is that they are all manifestations of motion—vibrations of a subtle imponderable material, called ether, which is supposed to pervade all

space and fill up the interstices left between the constituent molecules of all matter. The molecules of which all things are composed are of a spheroidal form, and therefore, however small and closely they may be packed, of necessity leave interstices.

There is this difference in the production of sound and that of heat, light, or electricity. The vibration of elastic bodies only can produce the sensation of sound, and these vibrations have to be transmitted through some *ponderable* medium such as air, gases, vapours, liquids, or solids. The number of vibrations differs with the pitch. The number of vibrations necessary for the production of audible sound is much lower than the number of vibrations of ether necessary to produce heat, light, or electricity, and the range from the deepest to the most acute sound is according to Helmholtz from 30 to 38,000 vibrations per second. The vibrations of elastic bodies producing sound are transmitted to and produce a vibratory motion in the ponderable molecules composing matter, and these vibrations are comparatively slow. In the case of heat it is assumed that the imponderable elastic ether, to which I have before referred, is in a state of rapid vibration, and that these vibrations, transmitted to material objects, set their molecules into more

rapid motion and thus increase their temperature. When the motion of the particles of undulating ether approaches a rapidity of several hundred of millions of millions per second heat of various intensity is produced; when the number of undulations increases up to about double the rate which produces heat we have the various tints of light which are capable of being appreciated by the optic nerve. "The optic nerve is insensible to a large number of vibrations. It can apprehend only those waves that form the visible spectrum. If the rate of undulation be slower than the red or faster than the violet, though intense motion may pass through the humours of the eye and fall upon the retina, yet we shall be utterly unconscious of the fact, for the optic nerve cannot take up and respond to the rate of vibrations which exist beyond the visible spectrum in both directions." (Ganot.)

When lecturing before the Royal College of Physicians in 1847 Dr Golding Bird alluded to the possibility of electricity being dependent upon ether assuming vibratory movements differing in amplitude and velocity from those producing light, heat, and photographic effects. Faraday upheld the *molecular theory* with regard to electricity, that is, that it is due to certain peculiar conditions of the molecules of bodies

that have been rubbed or heated or acted upon by light; or of the ether which is believed to almost surround these molecules. Since then Prof. Clerk Maxwell has proposed the theory that the phenomena of electric currents and magnets are due to rotations, streams, or other forms of movement in the particles of ether, while light is due to vibrations of it to and fro. In 1845 Faraday discovered that a ray of light polarised in a certain plane can be rotated by the action of a magnet so that the vibrations are executed in a different plane. If iron filings be magnetised they can be seen to rotate and place themselves endways; they then act as a magnet until shaken up. "There seems indeed reason to think that magnets may be merely made up of rotating portions of electrified matter" (Prof. Silvanus Thompson). The above theories of electricity and magnetism are very different to the old notion of fluids.

Electricity, therefore, is not a substance, but *an induced condition of matter* and a condition which can be transferred from one body to another.

To say the least, the relations between sound, heat, light, and electricity are so remarkable that one can never be excited without calling into existence one or all of the others. Heat produces electrical currents and by galvanic action the

most intense degree of heat hitherto known has been obtained. We are all at present conversant with the luminous properties of electricity. One of the most extraordinary relations between light and electricity was discovered in 1875. The metal selenium was found to change its electrical resistance under the influence of light. When properly prepared a sheet of selenium which offers a resistance of 300 ohms in the dark when exposed to the sunlight has a resistance of only 150 ohms. The greater the light the greater the reduction of resistance. This fact has led to the construction of the *photophone*, by which sound is transmitted to a distance by a beam of light. The sound of the voice is made to throw into vibration a thin mirror from which a beam of light is transmitted to a receiver, at a distance, made of selenium on which it falls with varying intensity, thus affecting the selenium, which is connected in circuit with a small battery and a Bell telephone in which the sounds are reproduced by the vibrations of the current.

It has been recently realised that all true solid conductors of electricity must be opaque to light.*

But electricity will also produce sound. When a strong electric current is passed through

* The above facts have been obtained from Prof. Silvanus Thompson's work upon 'Electricity and Magnetism.'

a rod of soft iron, a distinct sound is produced at the closing and opening of the current. This sound has been attributed to the vibratory motion produced in the molecules of the iron by their magnetisation and demagnetisation.

All physicians recognise the influence exerted upon health and disease by heat, light, and motion in the form of exercise, but very little attention has been paid to the place which electricity occupies in regulating the action of the vital processes. That it has a great influence upon the maintenance of health and the production of disease I shall try to prove by argument in a subsequent part of my thesis, but I must first apply myself to carrying out the task I have undertaken, that is, to show briefly the advance made in the application of electricity to medicine during the last 100 years. We have now more accurate means of measuring electricity and have a more perfect knowledge of its action, but although much has still to be learnt under this head, we are altogether in a far better position for employing its effects in the treatment of disease.

Concerning the Manner of its Application.

I have very little fresh information to add with regard to the treatment by statical electricity. The manner of its application is the same now as was employed at the time Dr Steavenson wrote his thesis and is therein fully described.* But this mode of treatment was used for many years after the introduction of galvanism and faradism as the most preferable, and long lists of cases were published in the 'Guy's Hospital Reports,' by Addison,† Golding Bird,‡ and Sir Wm. Gull,§ in which its use was followed by most satisfactory results. But now it has fallen very much into disuse, the constant and interrupted currents having been found so greatly superior in the ease with which they can be applied and also more beneficial in the treatment or relief of diseases dependent upon evident organic changes. But in those diseases which are only functional, and in certain abnormal conditions of the system (*e.g.* hysteria, nerve-prostration), I think that possibly statical electricity in the form of the positive electric charge‖ will be found very useful. Now

* Op. cit., p. 5.

† 'Guy's Hosp. Reports,' 1837, No. 2.

‡ Ibid., 1841. § Ibid., 1852–53.

‖ This method, in the thesis of 1778, is called *Insulation.*

that the electroscope will show clearly the electrical condition of every patient, the indication for such treatment becomes at once intelligible and easy of application.

In the application of galvanism and faradism the resistance offered by the skin to the penetration of the current has to be taken into consideration. This resistance varies much in different individuals and at different times in the same individual, a warm moist skin conducting better than a dry and cold one. The average resistance offered by the skin has been stated to be equal to about 2500 ohms or about 76 miles of copper wire of one millimetre diameter. In the application of electricity this resistance can be very much reduced by well moistening the skin with warm water, and better still with warm salt water; saline solutions conduct electricity much better than pure water. Where the skin is thick, as on the hands and soles of the feet, the resistance offered is much greater than in other parts of the body. If we want simply to influence the skin and do not want the current to penetrate to the muscles or deeper parts it is best to let the skin remain unmoistened. The body when immersed in water, as in an electric bath, is a better conductor than the water surrounding it, and a current of electricity sent through the bath will penetrate and traverse the

human body, but if salt be added to the water, the solution will then become the better conductor and the current will traverse it and not enter the body at all.

The weather also has a great effect upon the resistance of the human body, possibly by its effect on the condition of the skin. Lunatics, whose skins are in some forms of mental disease unnaturally harsh and dry, offer an extraordinary amount of resistance to the passage of an electric current. Very frequently patients say that the degree of paralysis and the sensation in a paralysed part are very much affected by changes in the weather, as is also the resistance. In warm weather or when a change takes place from cold to warmer weather an improvement in the paralysis is experienced; and on the contrary when a cold day supervenes on warmer weather the paralysis is worse and the muscles feel stiff and contracted.

When two electrodes are placed upon the body and a current is passed of sufficient strength to penetrate the skin, the current will pass from the positive electrode to the negative one, but in its passage it is diffused in the form of curves spreading out until a point midway between the two electrodes is reached, when it begins to converge again towards the negative electrode. The

greatest intensity of the current traverses a direct line between the two electrodes, but the farther they are apart from one another the more the current is weakened on account of its greater diffusion.

To produce an effect upon an organ therefore the more the current can be localised the greater is the influence exerted. A weak and therefore often painless current can be used if applied locally, but if not so applied a much stronger current would be required to produce the same effect and one perhaps not able to be borne without an anæsthetic. Many of the good results of electricity have been unattained and entirely disbelieved in because the current has been passed through the body in a haphazard way, often with the patient only holding the handles of some kind of electrical machine, which has produced most uncomfortable sensations and sometimes pain, with very little appreciable effect upon the organ it was wished to influence and which possibly was situated in some remote part of the body.

Different methods are employed in applying galvanism and faradism according to the texture it is wished to influence and also for the effect it is desired to produce.

Duchenne, who almost exclusively used the interrupted current, followed what is called "direct

faradisation;" that is, he applied both electrodes to the surface of the muscle he wished to influence. If the electrodes were not large enough to cover the whole surface of the muscle he applied them successively to all parts of it. The "indirect method" which was proposed by Remak and carried out by Ziemssen, consists of placing one electrode on an indifferent part of the body and applying the other to the "motor point" of the muscle it is wished to influence.

For diagnostic purposes, that is, for determining the electro-contractility of a muscle, a combination of the two methods just mentioned is advisable, namely, placing one electrode on the "motor point" and the other upon the muscle itself. When it is wanted only to influence the skin one moist electrode should be placed on an indifferent part of the body and the other, a dry one, should be applied lightly to the affected part, the skin also remaining dry.

For general faradisation one electrode may be placed on an indifferent part of the body, or the feet placed on a metallic plate, and the whole surface of the body sponged over with the other electrode.

In the use of galvanism for treatment two methods are followed; one the "stabile" when both electrodes are kept perfectly stationary, the

current passing evenly between the two points; and the other the "mobile," when usually the negative electrode is moved over the limb or the part it is wished to influence. In both methods it is usual for one electrode to be placed on an indifferent part of the body. The most convenient electrode for this purpose is an oval plate of pliable metal such as tin with a layer of amadou to retain the moisture, and all covered by a piece of wash-leather or flannel with a waterproof back to protect the patient's clothes.

If the galvanic current be employed for stimulating muscle to contract, as when for diagnostic purposes it is required to elicit the reaction of degeneration or prove its absence, it must be interrupted, for contractions only occur at the moment of making or breaking the current. The direction of the current is not of so much importance as the position of the poles. The greatest chemical and thermal action taking place at the negative pole and, in healthy muscle, the strongest contraction also takes place at the point of the application of the negative pole.

What is called "central galvanisation" consists in applying the negative electrode in succession to the nervous centres, the brain, spinal cord, and sympathetic in the neck; the other electrode being placed on the epigastrium or some other remote

part of the body. This method of electrisation is generally employed when it is sought to influence the whole nervous system, as in states of great nervous depression or exhaustion after long illnesses, or in cases of nervous insomnia.

I have omitted to mention the many applications of electricity to surgery as not coming within the scope of a medical thesis.

Concerning its Manner of Working.

A hundred years ago, when only statical electricity was known, it was suspected that it exercised some influence upon the human body other than that of a stimulant.* The electrolytic power of electricity† had not been discovered, although to it, possibly, was due many of the formerly considered marvellous phenomena. The fact that the galvanic current decomposed chemical compounds enabled Davy, in 1807, to isolate several additional elements, such as sodium and potassium. Since then numerous properties have been detected as belonging to electricity. Those affecting the human body have been divided into

* 'De Electricitate,' 1778, p. 13.

† In 1789 it was first discovered that water could be decomposed by passing through it a series of discharges of statical electricity.

mechanical, physical, chemical, and physiological. The first three affect both organic and inorganic matter, but not in the same way, the presence of life modifies the action; but the physiological effects of electricity are peculiar to living beings, and are simply modifications of the ordinary vital processes. Electricity may increase, diminish, arrest, or otherwise modify their action; it affects secretion and excretion, absorption, reflex action, and nutrition.

The physiological action of the induced current is almost *nil*. The duration of the transit of the current is not sufficient to produce any of the characteristic effects of the passage of a current of electricity, and the currents are alternately in a reverse direction. They only produce a momentary contraction of muscular tissue as is produced at every make and break of a constant current. But the makes and breaks are so rapid that the muscle has not time enough to relax between each, and a prolonged tonic contraction results as long as the application of the electricity is continued, or until the muscle relaxes through sheer exhaustion.

Although perhaps the induced current may reduce the amount of blood flowing to a part during its application by causing contraction of the muscular coats of the vessels, there is no doubt

that after the application has ceased a re-action sets in and a warmth is experienced in the part of the body operated upon through dilatation of the vessels and the consequent freer supply of blood to the part. But the physiological action of the constant current is of a much more complex nature, and is not yet thoroughly understood. But it is probable that it does not produce relaxation of muscular contractions and therefore cannot be said to have a distinctly opposite effect to the induced current. There is no doubt it induces an increased flow of blood to a part of the body included in the circuit, especially at the neighbourhood of the application of the electrodes, and there must be a corresponding dilatation of the vessels to allow of this increased supply of blood. But whether the dilatation of the vessels is due to a relaxing influence the current has on their muscular coats or the chemical changes produced in the tissues supplied by those vessels and necessitating a freer supply of blood is an undecided question.

The constant current does produce contraction of muscular tissue, just as the induced current does, at every make and break, but the redness of the part is produced if a moderate current as regards strength is allowed to flow continuously for a very short time, the previous or subsequent

making and breaking of the current appearing to have no effect upon it.

It is probable that changes are induced in the ultimate tissue cells of a part exposed to a constant current of electricity analogous to the chemical action produced in the electrolysis of water. If the current is weak the process does not go so far as splitting up the watery parts of the cell into oxygen and hydrogen, but produces some sort of activity in the cell not present there before. It increases or alters the character of the secretion of the cells composing secreting glands as evidenced by the increase of saliva and metallic taste in the mouth produced by the application of a continuous current of electricity anywhere in the neighbourhood of the salivary glands. This probable increased cellular activity, the quickening of the building up and destruction of cells never-ceasingly going on in the living body, is sufficient to account for the increased demand for blood required for these changes, and the resulting increased supply afforded by the dilatation of the capillaries. The capillaries do not dilate by any power possessed by the constant current to cause muscular relaxation, but secondarily through nervous influence excited by the demand produced in the cells for more blood. The action of the constant current upon muscular tissue, if anything

beyond, besides inducing these probable changes in the ultimate muscular elements leading to increased activity in the ultimate cells, increased nutrition, and therefore increased tone (as it is called), is probably to induce contraction rather than relaxation.

In considering these changes in the cellular elements of the body and in the blood supply the osmotic power of electricity must not be forgotten. It has been found that if two fluids of different densities be divided by a porous diaphragm and an electric current be made to pass through them osmosis takes place in the direction of the current. If the current passes from the lighter to the denser fluid the natural osmotic action is increased; but if the current passes in the reverse direction the osmotic action is reversed, the denser fluid passing through the diaphragm into the less dense. The osmotic power of electricity probably explains the influence of galvanism in causing the absorption of fluid effused into joints or serous cavities when applied in such cases.

In a recent paper on the formation of uric acid Dr Latham, the Downing Professor of Medicine in this University, has sought to prove that the presence of uric acid in the blood is due to the imperfect metabolism of glycocine, which takes place under certain conditions, one being an

insufficient amount of exercise. When a proper amount of exercise is taken the glycocine is transformed into urea and normally eliminated by the kidneys. He has also sought to prove that this more-to-be-desired metabolisis is dependent upon a due amount of nerve force, and that the production of nerve force is encouraged by exercise. It has also been proved that the contraction of muscle produces electrical currents. After passing on to describe the electrolysis of urea carried out by Professor Dewar, also of this University, Professor Latham makes the interesting remark that "if there be any correspondence at all between nerve force and the electrical current, this experiment possesses great significance."

As a matter of fact we do not know what nerve force is or what electricity is; they are both possibly modifications of motion as has been suggested is the case with heat and light. All we know is that the only distinctly appreciable change in a nerve during the passage of a nervous impulse is an electrical one (Michael Foster). It would be a happy result of the inquiries above alluded to if in the future we should be able to prevent gout by the application of electricity.

In many cases, it seems to me, the natural nervous force or impulse, as it is called, is almost wanting or very much reduced in strength.

Such cases occur after very severe and prostrating illnesses, and also in persons who from some cause or other, such as mental strain, anxiety, grief, exhaustion from bodily exertion, and the like, are brought down to a condition which is called "being below par." In some families this condition of health, or non-health, seems to be constitutional, many members being characterised by an apathetic phlegmatic temperament, to whom the performance of any of the active vocations of life seems a trouble; they want rousing and influencing by some unwonted stimulus to make them take an interest in, or do, anything. In many such people I have observed conditions which have led me to suppose that the natural nerve force or current is decreased in amount. Although their electro-sensibility is not impaired or the resistance they offer to electricity increased, it requires a much stronger current than usual to produce muscular contraction, and therefore I should argue, that it requires a much greater mental effort or a much greater excitement for the production of electrical separation (when artificial stimuli are not applied) to produce muscular contraction or mental activity of any sort. The normal amount of electrical separation going on in the body is reduced in quantity, or the centres for producing electrical separation (if

such exist) are not executing their function to the full extent. I can suppose that such a centre for electrical separation does exist and that it is most likely situated in the medulla. I have noticed this reduction in electrical excitability especially to follow severe cases of typhoid fever while patients are in that childish and semi-idiotic state which not so very infrequently accompanies convalescence from that disease. And general galvanisation quickly restores such persons to a proper nervous and mental condition, gives them courage and buoyancy of spirits, and generally improves their nervous tone. But it is not necessary to demonstrate the presence of an electric centre in the human body to argue that electrical separation does, and is continually taking place. McKendrick, who denies the existence of such a centre to all but a few fishes and animals, allows that electrical separation takes place in the muscles at the moment of contraction and in the retina of the eye on the incidence of light, due in his opinion to chemical changes. All the vital processes of the body, the building up and degeneration of the tissues, digestion and secretion, are accompanied and carried out by the means of chemical processes, and in this human laboratory is it to be maintained that all these chemical reactions take place without the production of

electrical separation? On the other hand, in reality, may not the body be looked upon as a collection of innumerable small batteries continually splitting up electricity into its positive and negative components?

In living nerve there is always a natural nerve current which can be detected by a galvanometer. The only change we are at present cognisant of as accompanying a nervous impulse is a negative variation of this natural nerve current. It is not dependent on the nature of the stimulus which produces the nerve impulse, that is, it may be chemical, mechanical, or electrical, or from one of those modifications of motion known as sound, light, or heat. Of the nature of the action of organic or vital stimuli we know very little (Michael Foster). The rate of travelling of the negative variation along a nerve is 28 metres per second and is identical with the rate of travelling of a nervous impulse. The negative variation passes in the form of a wave. The whole wave takes ·0007 of a second to pass any given point of a nerve. The length of the wave is 18 millimetres. Therefore a nervous impulse is a molecular disturbance propagated along the nerve in the form of a wave of the length of 18 millimetres and possessing a velocity of 28 metres per second.

The experiments of physiologists of the present

day on the action of electricity upon nerves and the natural nerve currents have been confined to the action of dynamic electricity in the form of the constant current or the interrupted current. I can find no experiments as to the electrotonic condition of nerves under the application of statical electricity; for example when a length of nerve is charged positively. When a constant current is passed we know that the normal nerve current is increased about the region of the positive pole. This corresponds to the observed action of a positive charge in improving the general nervous tone of the body. The negative charge produces a condition of body as of utter prostration, similar to that produced by blood-letting, and similar to those conditions I have described as accompanying great prostration from severe illness or other causes when the irritability or normal condition of the nerves has deteriorated, the natural nerve current diminished, or the nerves are in a condition of permanent decreased excitability.

The relationship between electricity and nerve force has given rise to much controversy. Sir John Herschel* hints at this relationship and supposes that the brain may be either the organ of secretion or at least of the application of the *vis nervosa;* he remarks, "If the brain be an

* 'Discourses on the Study of Natural Philosophy.'

electric pile constantly in action, it may be conceived to discharge itself at regular intervals, when the tension of the electricity reaches a certain point along the nerves which communicate with the heart and thus to excite the pulsations of that organ." Dr Arnott also hinted at some such cause being the active agent in keeping up the regular pulsations of the heart.

Dr Golding Bird did not believe in the identity of electricity and nerve force, but believed that as electricity will excite magnetism in a bar of soft iron so will electricity excite nerve force in the brain or nervous cords. Drs Beard and Rockwell in their work on 'Medical Electricity' say that "between the behaviour of electricity in animal bodies (animal electricity), electricity in general (statical and dynamical electricity) and magnetism there are analogies so close and so consistent as to warrant the view that all are but *different manifestations of one force*." Dr Vivian Poore says that "the inference has been, by some, too hastily drawn, that nerve force and electrical force are identical. That the two forces are related in so far that the one most readily excites the other there can be no doubt, and that they are very closely correlated there is every reason to believe, but that they are not identical the following reflections seem to show:

"1. The rapidity of the transmission differs—that of electricity being estimated at 462,000,000 of feet per second, and that of nerve force at only about 200 feet per second.

"2. Nerve force is not conductible along a metallic wire.

"3. Cold diminishes the conducting power of nerves for nerve force, whereas it increases the conducting power of solids or fluids for electricity.

"4. The crushing or compression of a nerve destroys its conductivity. It may be, however, that the crushing of a nerve is analogous to the breaking of the copper conductor in an insulated telegraph wire."

To this it should be added that when a current of electricity is passed along a nerve it only travels at the same rate as nerve force. And the argument that a ligature placed upon a nerve arrests the passage of a nerve impulse, and would not arrest an electric current, is not altogether true, for an electric current of low tension passed along a nerve can be stopped by the application of a ligature.

Dr Michael Foster dismisses this question by asserting that "of the nature of the action of organic or vital stimuli we know very little."

One of the most interesting facts connected with

the influence of electricity upon nerve force has been shown by experiments carried out by Dr Poore. He has proved that the passage of the continuous current through muscles or the nerves supplying them, increases their susceptibility to the stimulus of the will, and also their endurance for voluntary muscular action. He found that a weight of seventeen ounces could be held out in the hand at right angles to the body for double the time when a constant current was passed through the arm than when no electricity was used. He also found that the force of voluntary muscular action measured by the dynamometer could be very greatly increased by the passage through the arm of a galvanic current. It was found that galvanism increased the force of the squeeze of his own hand about eleven pounds. A greater increase was obtained in experiments upon other individuals. This property of the constant current in restoring the excitability of exhausted muscles has been called its *refreshing effect.*

We have of late years begun to recognise the influence of the physical phenomena upon the conditions of health and disease. We know that the humidity of a locality as affected by the subsoil drainage has more influence upon the prevalence of phthisis than any amount of hereditary predisposition or abundance of bacilli; that the baro-

metric pressure influences the blood pressure; that electrical changes in the atmosphere, as on the approach of a thunderstorm, influence strongly many persons possessed of delicately strung nerves; that sound in the form of music has also an influence upon the circulation, no doubt through the vaso-motor system, but how that system is affected by music we do not at present understand. We also know that the varying vibrations of ether producing light of different colours have a great influence in the treatment of the insane. How these several influences act we are not as yet able to explain. The difference produced in highly sensitive or nervous people by sudden and marked changes in the weather, especially sudden changes of temperature to which this climate is so liable, is due to the electric changes produced in the individual.

It is a well-known and recognised fact that a few hot days in succession so change the electrical condition of the surface of the earth that a thunderstorm is often necessary to restore equilibrium. It is impossible for human beings to remain at a position of zero with regard to electrical potential when the potential of every object around is varying. Induction alone would produce electrical separation. It is fortunate for us we live in a climate with the atmosphere so

charged with moisture that the varying electrical conditions can be more easily equalised. If such sudden changes of temperature took place in countries with a dry atmosphere the inhabitants would suffer considerably. Perhaps these climatic conditions have more influence in producing the peculiar characteristics of race than has been supposed. The self-possession and undemonstrative demeanour of an Englishman may be due to the more ready equalisation of electrical disturbances, and the excited and vivacious tendencies of the denizens of more southern climes to an absence of the chief means for restoring equilibrium. In those parts of the earth where the air is very dry the manifestations of animal electricity recorded are almost incredible to the inhabitants of these islands. Rubbing the feet a few times on the carpet will enable an inhabitant of the Southern States of America to light the gas by the spark which will pass when he presents his finger to the metal point of a gas burner; and electrical displays are produced by combing the hair, which a moist atmosphere alone prevents us from perceiving in this country.

There are good reasons for believing that the electrical conditions of the atmosphere influence health. I have deferred reading my thesis hoping to have had more leisure or opportunity for ob-

servation and experiment. I hoped to have been in possession of incontrovertible facts that electrical conditions of the atmosphere *do* influence health. I can now only argue from what has already been written that *it is likely* that they do so and show in what direction I hope to be able to prosecute inquiry. I have therefore to resort to the observations of others and can only draw deductions from the facts which they detail. But these facts in many instances bear out the statements of eminent observers quoted in my former thesis.* If they be compared with the facts recently discovered concerning atmospheric electricity and terrestial magnetism they will in many instances be found to correspond. But this result seems to me to be certain, that if differences in the electrical condition of the earth do take place and are continually taking place, a highly sensitive organism such as the human body must participate and take cognisance of these changes, and it is not too much to suppose that these changes have some influence upon health.

To put my proposition in another way. All conditions of the atmosphere which have been noticed to influence health prejudicially are accompanied by a development or increase in the amount of negative electricity. Before a thunder-

* 'Spasmodic Asthma,' 1879.

storm, when many people of a delicate nervous temperament assert that they feel indescribable "malaise" and oppression, the atmosphere in the neighbourhood of the earth is negatively electrified, and I have known ladies made to feel extremely ill when attending a lecture on electricity accompanied by experiments when a large amount of free electricity has been produced. The positive variety being more easily conducted away there remains an undue amount of negative electricity.

In my thesis on Asthma for the M.B. degree I hinted that possibly the varying electrical conditions of the atmosphere might explain the seemingly unaccountable conditions which influence and produce an attack of the disease.* Since then the struggle for existence which young physicians have to maintain has prevented me devoting the time I could have wished to investigate this theory further, nor am I able to discover that very much additional knowledge has been obtained by those who have had time to prosecute investigation. "We know that the electrical potentials of different places on and in the earth differ considerably, sometimes to the extent of

* 'Spasmodic Asthma.' A thesis for the M.B. degree of the University of Cambridge. By W. E. Steavenson. Cambridge: Deighton, Bell & Co. 2nd edition, pp. 9-17.

several hundred volts."* "We obtain this information from the currents observed to flow through wires joining parts of the earth widely separated."† "Electrified masses of air moving at no great distance from the earth's surface are continually altering the distribution of electricity," "which is, however, generally found to be negative on the earth's surface."

Sir William Thompson found that the potential of the air varied very rapidly near the surface of the earth. Thus he has observed a difference of potential between the earth and the air nine feet above it, equal to 430 volts in ordinary fair weather, and in breezes from the east‡ and north-east as great a difference as this per foot of air. The potential is perpetually fluctuating, even in fair weather. "The potential of the air appears to be generally positive in fine weather, and negative only during broken or rainy weather."

These recent observations point in addition to the suggestions I have made in my former thesis that the negative variety of electricity has a deleterious effect upon health.§ I believe I have produced a fit of asthma by charging myself with

* The electricity produced by one Daniell's cell=1·08 volts.

† 'Electricity and Magnetism.' By Prof. Fleming Jenkin, F.R.S.

‡ Thesis on 'Spasmodic Asthma,' p. 16.

§ P. 9, ibid.

negative electricity. This was the result of accident, as at the time I made the experiment I was under the impression that I was charging myself positively. The unpleasant result has not encouraged me to repeat the operation. Another member of this University, who suffers from asthma, tells me that he experienced a similar result when charging himself with electricity in the Cavendish Laboratory.*

In delicate individuals and persons of a nervous temperament the changes of weather, and especially an east wind, are known by common observation to act prejudicially. I know that attempts have been made to account for these effects in other ways. The recent observations of the daily variations of terrestial magnetism† accord very closely with the electrical changes by which I have tried to account for the periodicity and the exacerbations of dyspnœa in asthma.‡

* See also a case mentioned by Sir Thos. Watson in his lecture on "Asthma" in the 'Principles and Practice of Physic,' in which galvanism produced an attack of the disease.

† 'Electricity and Magnetism.' Prof. Silvanus Thompson, p. 120, 4th edition, 1883.

‡ Vide 'Spasmodic Asthma,' pp. 9, 10.

Diurnal variations of positive electricity in the atmosphere.	Ganot.	Quetelet at Brussels.	Stewart at Kew.	Daily variations of the barometer.*
1st minimum	Before sunrise, 3 to 6 a.m.	Midnight	—	Lowest, 4 a.m.
1st maximum	11 a.m.	8 to 10 a.m.	8 to 10 a.m.	Highest, 10 a.m.
2nd minimum	A few hours before sunset, 3 p.m.	3 p.m.	—	Lowest, 4 p.m.
2nd maximum	Sunset to 9 p.m.	6 to 9 p.m.	7 to 10 p.m.	Highest, 10 p.m.

* The same in all latitudes, but difficult to detect in the temperate zones as they occur in conjunction with accidental variations (Ganot).

In our climate the south-west winds, which are usually warm and therefore light, cause a fall in the barometer, and they are also usually charged with moisture from evaporation from the vast expanse of ocean they pass over and are therefore charged with positive electricity.

The east and north-east winds are cold and dry from passing over vast continents and are therefore denser, and cause a rise in the barometer and are usually accompanied by an increase in the negative electricity.

The predominance of positive electricity in foggy weather is the cause I have assigned for the

immunity then experienced from attacks of pure nervous asthma, though the ordinary dyspnœa accompanying bronchitis and emphysema is often increased.

When we consider that every vital process is most likely accompanied by the production of free electricity in our bodies,—that the incidence of every ray of light upon the retina,* our every act of thought, and certainly our every muscular movement has been proved to produce electrical currents; is it possible that the varying electrical conditions of the atmosphere can take place without influencing our systems? The electrical separation taking place in the human body is of a kind intended to counteract as much as possible the changes likely to be induced by the atmospheric electricity so that the normal functions of the body may not be unduly interfered with or arrested.

Although the earth and inanimate objects upon it are usually negatively electrified, human beings in a state of health are almost invariably found to be positive. When the body is insulated the electrical condition is easily made manifest by the use of a condensing electroscope. Dr Poore in his work on 'Electricity in Medicine and Surgery'

* Prof. McKendrick on 'Animal Electricity,' before the British Association for the Advancement of Science, September, 1883.

says, "It is remarkable that hardly any two persons are in the same condition electrically, and nervous irritable people are said to exhibit a more active electrical condition than persons of a phlegmatic temperament." Dr Golding Bird in his lectures before the Royal College of Physicians in 1847 attributes this existence of free electricity in the human body chiefly to evaporation and respiration and he sums up his observations on this point under the three following heads. That electricity exists in the human body:—

"1st. In a state of equilibrium, common to all forms of ponderable matter.

"2nd. In a state of tension capable of acting on the electrometer, giving to the whole body a generally positive condition, and arising in all probability from the disturbance of the normal electrical equilibrium by the process of evaporation and respiration.

"3rd. In a state of current, a dynamic condition, arising from the disturbance of equilibrium by the union of carbon with oxygen in the capillary system, and from other chemical processes going on in the body; such currents, although suspected to be everywhere existing, having been actually detected between the skin and mucous membrane, the stomach and liver, and the interior and exterior of muscular structures."

The good results derived from the use of statical electricity were probably misunderstood and did not depend upon the shocks given to the system of the individual but to the preliminary charging of the patient with the electric fluid which possibly counteracted the electric condition on which the illness of the patient depended; the morbid condition depending on the presence of an accumulation of negative electricity. As a matter of fact most patients when charged were charged positively.

Should I be able by future experiment to prove, what I very much suspect to be the case, that negative electricity exercises a baneful influence upon health and that many of the conditions of ill-health and depressed vital energy are associated with the development or presence of an increased amount of negative electricity in the human body, the form of treatment by statical electricity will again come into vogue and the electroscope will become an indispensable adjunct to the many instruments now employed in physical diagnosis.

Dr. ROBERT STEAVENSON
of NEWCASTLE on TYNE.
Born 1756, at Berwick-on-Tweed. Died 1828.

Arms as borne by Dr. ROBERT STEAVENSON, of Newcaſtle-on-Tyne.

Azure, on a bend *Argent* between two Lyons paſſant *Or*, three Leopards' heads *Gules*.

Granted unto *John Steavenſon* of *Stanton* and *Elton* in the *Peak*, in the County of Derby, and to his Deſcendants, by Sir *Thomas St. George* Garter, and Sir *John Dugdale* Norroy, the 14th of June, and 4th year of the Reign of King *James* the Second, *Anno Domini* 1688.

See Lyſon's "Magna Britannia," Vol. V. Derbyſhire. London, 1817. "Families extinct, or removed out of the County ſince 1500."

DISSERTATIO MEDICA INAUGURALIS, DE Electricitate et Operatione ejus in Morbis Curandis.

QUAM,

ANNUENTE SUMMO NUMINE,

Ex Auctoritate Reverendi admodum Viri,

D. GULIELMI ROBERTSON, S.S.T.P.

ACADEMIÆ EDINBURGENÆ Praefecti;

NEC NON

Ampliſſimi SENATUS ACADEMICI conſenſu,

Et nobiliſſimae FACULTATIS MEDICÆ decreto,

PRO GRADU DOCTORATUS,

SUMMISQUE IN MEDICINA HONORIBUS AC PRIVILEGIIS RITE ET LEGITIME CONSEQUENDIS;

Eruditorum examini ſubjicit

ROBERTUS STEAVENSON, A.M.
BRITANNUS.

Soc. Med. Sod. nec non
Soc. Phyſ. Chir. Soc. Hon.

‘ Nil mortalibus arduum eſt.
‘ Coelum ipſum petimus ſtultitia : neque
‘ Per noſtrum patimur ſcelus
‘ Iracunda Jovem ponere FULMINA.

Q. HORAT. CARM.

Ad diem 24. Junii, hora locoque ſolitis.

EDINBURGI:
Apud BALFOUR et SMELLIE,
Academiae Typographos.

M,DCC,LXXVIII.

Juveni ornatiſſimo

GUALTERO OGILVY,

ARMIGERO,

Filio natu maximo

Joannis Ogilvie de Innerquharity,

Equitis Aurati,

Omnibus, ob morum comitatem,

Illi, tam ob familiaritatem,

Dum in Academia Andreapolitana

Philoſophiae ſtudio per triennium verſabantur,

Quam ob amicitiam

Qua ſibi inde devinxit,

Chariſſimo ;

Nec non,

Senatori illuſtriſſimo

JACOBO WILKINSON,

ARMIGERO,

In rebus publicis,

Æque ac privatis adminiſtrandis,

Spectatiſſimo,

Ob morum ſuavitatem et elegantiam,

Ob vitae quinetiam probitatem,

Inſigni ;

Denique,

Eruditiſſimo

JOANNI BURN, M. D.

Artem Appollinarem apud Bervicenſes,

Summo cum honore ſuo,

Et civium ſalute,

Exercenti,

Æque ob praecepta in re medica,

Dum, illo auſpice, aegros quamplurimos

Per triennium viſitabat,

Colendo ſemper et venerando,

Ac ob conſilium amicitiamque,

Quibus ſe dignatus eſt,

Dum in academia Edinenſi,

Per quadriennium ſtudio medicinae incubuit ;

Haſce ſtudiorum primitias

Laeto Animo dicat

AUCTOR.

DISSERTATIO MEDICA

INAUGURALIS,

DE

Electricitate et Operatione ejus in Morbis Curandis.

SICUT genus humanum ex ſtatu inculto et barbaro, ad morum comitatem et urbanitatem progreditur ſenſim, ita philoſophia ex primo quaſi diluculo ad perfectionem procedit. Uno in ſeculo, caſus fortuitus vel ingenium profundum diverſis artibus et ſcientiis originem praebuit, ſeculorum autem ſequentium induſtria et experientia magnopere haſce excoluit. Tametſi non nobis videtur, antiquos recentioribus ingenio ſecundos fuiſſe, attamen hi ſua experi-

entia ad illorum ingenium accedente, plurimis ſcientiae partibus, et praecipue phyſicis, illis longe praeeunt.

Scientia ita ſenſim ad ſtatum cultum perveniente, electricitas non niſi in ſeculo praeſenti in lucem prolata erat; quamvis enim ſcriptores antiqui corpora memorabant, quae poſt frictionem corpora leviora ad ſe adtrahendi virtute praedita erant; nihilominus, hoc ex fluido jam electrico dicto pendere omnino neſciebant. Fulgur, olim quaſi Deo ipſi ſacrum, et mortalium impiorum flagellum, ducebatur; hodie autem per ſyſtema mundanum quaquaverſum diſpergi, et aegris ſanitatem reddere, repertum eſt; ex fluido enim pendet electrico, quod aeque e terra excitari ac nubibus extrahi poteſt, et per quod unumquodque fulguris phaenomenon imitari queat.

Phaenomena quidem plurima ex hoc fluido originem ducere, quarum cauſae philoſophis ſeculi prioris omnino erant ignotae, jam recte intelliguntur; monſtraverunt enim noſtri auroram borealem, terrae motus, turbines,

bines, meteora, &c. a fluido electrico prorſus pendere. Electricitas multa praebet phaenomena, quae ad animi oblectationem, quam ad vitae commodum, aptiora fuiſſent, niſi Franklin ingenio praeſtantiſſimus, ſcientiam ejus de electricitatis viribis ad fulguris ictibus periculo plenis obviam eundum, et Jallabert ſuam ad morbos ſanandos fauſte converterant; etſi autem plurimi cognoſcuntur electricitatis effectus, nobis tamen affirmare licet, multos adhuc tenebris involutos eſſe.

Quamvis electricitatem inter remedia maxime pollentia hodie merito locum habere conceditur, vires adhuc, per quas ex corpore humano morbos tollit, haud ſatis cognoſcuntur; quamobrem empirice quaſi utitur. Statuimus igitur Modum Operandi ejus, quam optime poſſumus, explicare et dehinc Morbos enumerare in quibus curandis maxima pollicetur: Imprimis autem

DE MODIS APPLICANDI,

pauca ſunt dicenda. Fluidum electricum plurimas poſſidet qualitates maxime mirabiles,

biles, quarum paucas attentione noſtra praecipue dignas enumeremus, quia rationis applicandi, et forſitan agendi explicationi, inſerviant.

1*mo*, Syſtema terreſtre undequaque pervadit, adeo ut corpora omnia certam poſſident quantitatem quaſi latentem, et hac ſub conditione, corpora fluido electrico ſatiari, et fluidum electricum aequilibrium et requiem tenere, dicuntur.

2*do*, Frictione quorundam corporum, e. g. cylindri vitrei, &c. aequilibrium et requies turbantur, et tunc temporis *excitari* fertur.

3*tio*, Ex corporibus quibuſdam extrahi et alibi deduci, in aliis accumulari et denſari, et in omnibus ſitus mutari, poteſt: Dehinc corpora, quoad fluidum electricum, in duas dividuntur claſſes, nempe, Excitantium, quae *Electrica*, et Deducentium, quae *Conductores*, appellantur. Ad claſſem poſteriorem pertinent metalla, fluida vel humida, carbones et terrae micaceae; corpora fere omnia alia inter electrica enumeranda ſunt. Porro, obſervandum eſt, corpora quae fluidum electricum

cum excitant non id deducere, quam ob cauſam *Non-conductores*, et ea quae ducunt haud excitare, atque adeo *Non-Electrica* deſignantur.

4*to*, Siquando aequilibrium turbatur, e. g. ſi in corpore quovis fluidum electricum accumulatur, ſive ex quovis tollitur, ſive in cujuſvis corporis parte vel ſuperficie una accumulatur et denſatur, dum ex altera ejuſdem ſuperficie auferatur, (quod in experimento Lugdunenſi accidit) conductore admoto, infinita et pene incredibili velocitate aequilibrium renovatur.

5*to*, Conſtanter alios aliis anteponit conductoribus, etſi longe ex curſu recto deflectitur, e. g. carboni metalla, et fluidis anteponit carbonem ; proximis autem itineribus, (caeteris paribus) aequilibrium petit.

6*to*, Subtilitate et mobilitate gaudet eximia, adeo ut corpora ducentia facillime pervadit, atque *Electricis* (e. g. vitro, &c.) inſidet, quamvis haec non pervadit.

Ex hiſce proprietatibus electricitatis ad corpus humanum tres ſunt applicandi modi, quorum

rum uno, qui *Inſulatio* vocatur, fluidum electricum excitatum interventu electrici, quo minus ad corpora circumjacentia tranſiret, prohibetur, unde neceſſario in corpus humanum cumulatur. Dum haec perficitur operatio, fluidum electricum corporis latebras unaſquaſque intimas pervadit, et ad aërem externum gradatim celeritate pluri vel minore, pro humiditate ſiccitateve aëris, per porum unumquemque evolat, et fluida ſecum ducit. Hicce modus applicandi, fluidi electrici excitati qualitates nativas exhibet, perſpirationem affatim adauget, cordis et arteriarum pulſationes quodammodo accelerat, ſudorem ſaepe elicit, et ſecretiones univerſas promovet.

Si corpori inſulato et fluido electrico excitato plus juſto onerato *Conductor* ſubito applicatur, fluidum redundans illum maxima petit velocitate, et (dummodo accuminatus non ſit) forma ſcintillae luminoſae vix corpus relinquit, atque parti dolorem et ruborem per impulſum ſuum infligit; vel ſi conductori inſulato et fluido onerato corporis humani pars quaevis applicatur, ſcintillam

lam et ictum accipit. Horum modorum prior eoſdem pene ac inſulatio edit effectus, ſtimulo topico mechanico conjunctos, poſterior vix alium praeter ſtimulum praebet topicum mechanicum. Si igitur effectus generales aeque ac ſtimulum topicum deſideramus, *Scintilla* aegro inſulato extrahenda eſt; ſin autem ſtimulum topicum ſolum volumus, *Scintilla*, ei non inſulato, danda.

Si fluidum in ſuperficiem unam corporis '*electrici per ſe*' dicti, e. g. laminae vitreae vel phyalae accumulatur et denſatur, ex altera ſuperficie copia aequali pellitur; electrica enim non niſi nativam poſſunt tenere fluidi quantitatem, quamvis locus vel diſtributio ipſius mutari queat; in ſuperficie una igitur diceremus fluidum, in altera, materiam praeponderare. Quamprimum autem communicatio unam inter alteramque ſuperficiem applicatione conductoris conſtituitur, aequilibrium velocitate plure aut minore, pro ratione ſuperficiei electrici, condenſationis fluidi, et conductoris perfectionis, et impulſu forti revocatur, velocitas enim et impulſus

fluidi

fluidi electrici, aeque ac aliorum fluidorum vi reſiliendi gaudentium, denſatione augetur. Dum fluidum electricum in ſuperficiem alteram phyalae vel laminae vitreae cumulatur, *Onerari* fertur, et ſi corpus humanum (quod fluidum electricum non niſi ope humorum ducit) communicationem unam inter alteramque ſuperficiem inſtituet, aequilibrium per corpus renovatur, corpus ictum accipit accerrimum vel *Succuſſionem*, et phyala *Explodi* fertur. Huic nomen *Succuſſus* imponitur, et fluidum hoc applicandi modo ſyſtema partim tantum, maxima autem pervadit velocitate; itinere enim rectiſſimo aequilibrium et diffuſionem petit aequabilem.

Quoad igitur electricitatis ad corpus applicationem, Inſulatio plurimis in morbis ſine periculo, et multis commodo, adhiberi poteſt; Succuſſus paucis tantum et in hiſce ſumma ſaepe prudentia. Scintillae quam Succuſſus magis, quam Inſulatio minus, frequenter admittendae ſunt.

Dum conductorum acuminatorum dotem, ſcilicet fluidum electricum cumulatum ſilen-

ter

ter et ſine ſcintilla e corporibus ſubito extrahendi, in animo verſabam, quarta applicandi forma, quae commodum pollicetur, mihi pervenit in mentem, quae, ut ab aliis diſtinguatur, *Penicilla* nominarem. Puncta fluidum excitatum avide attrahere apprime notum eſt; ſi igitur corpori humano inſulato, et fluido electrico plus jure onerato, admoveatur conductor cuſpidatus, fluidum exuberans, ſine impulſu, ſimul ſine dolore, hac ex parte forma penicilli luminoſi extrahetur; unde copia et velocitas fluidi per partem quamcunque placuimus tranſeuntis multum augeantur, et ſi ſpatium per quod fluidum effugit amplificaremus, tantum neceſſarium erit mucrones numero augere. Nulla adhuc feci experimenta, quamvis mihi eſt in animo quaedam ad hoc ſpectantia inſtituere; probabile enim mihi videtur, quod ad tumores Schirrhodeos ſolvendos, in quibus ſuppurationem omnino praecaveremus, admodum utile foret; forſan etiam in quibuſdam Phlegmaſiis commodo adminiſtrari poſſet.

Antequam huicce diſſertationis parti finem imponamus, obſervandum eſt, medicos electricitatis exhibitionem raro ſat diligenter proſequi; haud enim obliviſci debemus, quod, etſi electricitas morbos quoſdam ſubito et quaſi incantatione tollit, in aliis tamen diuturna eſt utenda perſeverantia; et, quamvis poſt ſpatium bimeſtre vel trimeſtre nullum ex illa aeger accepiſſet commodum, nequaquam tamen deſperandus eſt ſucceſſus; morbos enim haud aliter curandos poſt ſex etiam menſes ſuſtulit*. 'Shenſtone' autem dixit 'patience is a panacaea; but where is it to 'be found, and who can ſwallow it.'

DE MODO OPERANDI.

Ex animadverſionibus hiſce de applicandi modis, nobis conjicere liceat, electricitatis operationem diverſam, ſecundum applicationis diſſimilitudinem, fore; et revera compertum habemus, ſuccuſſionem nimiam eodem ac ictus vehementes modo vitam prorſus extinxiſſe,

* De Haen ratio medendi.

tinxiſſe, applicationes autem leniores membra torpida et quaſi mortua ad vitam revocaſſe.

De Modo Operandi in duas abiere partes viri docti, quarum altera vult electricitatem pro ſtimulo ſimpliciter agere, altera autem plurimis argumentis ſtabilire conata eſt fluidum electricum in corporibus viventibus ſenſationem et motum perficere, vel idem cum Fluido Nerveo eſſe*; et dehinc, fluidum electricum paralyſin tollere, vis nerveae copiam augendo, et itinere ſuo impedimenta movendo, crediderunt.

De priori autem opinione prius loquendum eſt; et ut illius in veritatem accurate inquiremus, ſtimulantium, ut et electricitatis, quibuſdam in morbis effectus ſpectemus.

Stimulantia in fibram nerveam vel ſentientem tantum agunt, quod ex nervi ſenſibilitate et quarundam ſenſationum intollerantia accidit; et dehinc muſculorum, praecipue ſanguinis circulationi inſervientium, contractiones aeque frequentia ac vi adaugent; nullum ergo, niſi quoad ob acrimoniam corrugant

* Deſhais a Montpellier.

gant vel rodunt, effectum in fibram non ſentientem primarium edunt.

Electricitas, e contra, Paralyſi medetur; vires autem ejus ſtimulantes hoc in exemplo phaenomena haud explicabunt; nervum enim neque ſenſatione nec motu gaudentem, et idcirco ſtimulo non excitandum, ſuſcitat, et hujuſce ſenſibilitatem et vires redintegrat.

Electricitas Amenorrhoeam amovet, et fluorem menſtruum ſexus ſequioris, ſanitati maxime neceſſarium, ſaepiſſime reſtituit, eo ut Franklin, qui multoties electricitate hoc in morbo uſus eſt, affirmat illam raro expectationem ſuam fefelliſſe. Stimulantibus autem fortiſſimis ſaepe ſaepius pertinaciter reſiſtit Amenorrhoea, et medicorum conamina deludit; ſic, vinum et exercitium cordis et arteriarum pulſationes, magis quam electritas, accelerant; ſi ergo hujuſce effectus ſtimulo ſolo penderent, vinum, &c. magis ad hoc pollerent propoſitum; ſed experientia hanc non ratam facit conſecutionem.

Tumores

Tumores* ſcirrhodei fluido electrico interdum ſolvuntur, nequaquam autem per vim ſtimulantem ; ex ſtimulo enim ſuppuratio potius timenda foret, et revera ſcintillae electricae, quae manifeſte ſtimulant, ſuppurationem properant.

†Calculorum per ureteres tranſitum accelerat electricitas ; ſtimulantia autem potius impedirent ; quicquid enim ureteres irritat, ſpaſmos inducit, et ureteris lumen anguſtum reddit, atque idcirco hoc in morbo nobis vitanda foret.

‡Electrizatio calvitiem amovet, et capillorum incrementum promovet, quae vi ſtimulanti haud tribuenda ſunt.

Dehinc nobis concludere fas eſſe videtur, quod, etſi vim ſtimulantem mechanicam ex momento ipſius pedentem, Electricitati certo in modo applicatae haud recuſemus ; qualitates tamen aliae in calculum operationis ſuae ſunt accipiendae, ut, Praxeos rationem praefinire, Indicationes idoneas ſtatuere, et quibus

* Med. Comment. v. 4. p. 82.

† Weſley's deſideratum.

‡ Carmichael tentamen, p. 33.

quibus in morbis commodum ab illius uſu expectandum eſt praedicare, queamus.

Cum ergo monſtravimus, hanc theoriam electricitatis effectuum horum explicationi imparem eſſe, ſententiam a Deſhais editam perſcrutemur, et argumenta ad opinionem ſuam confirmandum allata conſideremus.

1*mo*, Dicit, colliſiones fluida inter et ſolida animalium fluidum electricum in corpore ſponte latentem excitare, et hoc manifeſtum eſſe redditum per id quod animalium crinibus obtinet; ſi enim eorum capilli in tenebris fricantur, fluidum electricum ex hiſce evidenter effugere. Obſervandum eſt autem, hoc non a poteſtate pendere animalibus viventibus peculiari, verum ab *electrici* (nempe crinum animalium) frictione excitatum eſſe.

2*do*, Affirmat nervos, prae aliis ſyſtematis partibus, fluidum electricum ducere; quia, ſi canem viventem, poſtea quod grandem denudaveris et ſecueris nervum, electrizares, radii luminoſi ex nervo jaculantur. Hoc iterum non ex intima nervi fabrica, verum humiditate qua obtegitur, et ex acuminatorum

rum viribus nuper memoratis, pendet. Nervi electricitatem imperfecte tantum ducunt*.

3*tio*, Exiſtimat fluidum electricum, vel (quod ſecundum illum idem eſt) nerveum ad cerebrum, Tactus ſenſationem ad communicandum non redire, verum ad corpus quod tangimus tranſire. Huic autem reſpondemus, quod corpora aequali copia fluidi electrici gaudentia ſibi invicem electricitatem non communicant; fluidum autem electricum inter corpora electricis non disjuncta aeque diffunditur, et hac ſub conditione, nulla electricitatis oſtendit ſigna; rebus igitur ſic ſeſe habentibus, neque corpus noſtrum nec vicina ſentire poſſemus.

Porro, obſervandum eſt, quod energia nervea, aeque ſi *conductore*, ac ſi *electrico* nervus ligatur, prorſus dirimitur. Argumentum, denique, quod hanc theoriam ex toto ſubvertit adhuc reſtat; nam, ſi hoc obtineret, et ex ſyſtemate vivente fluidum electricum extra-

heremus

* Ab experimentis compertum habeo, nervos ſiccos haud omnino, recentes autem facile, fluidum electricum ducere, quamvis vix aeque ac corpus integrum.

heremus nativum, vim nerveam etiam tolleremus, et, ſi partim vim nerveam pro rata parte minueremus, res autem neutiquam ita ſeſe habet.

Hiſce ergo repudiatis, rationem Operationis electricitatis timide et diffidentur attingamus, et ideam noſtram hac de quaeſtione in medium proferamus: Imprimis autem quaſdam fluidi electrici qualitates, quae nobis actionem ſuam in corpus humanum inveſtigantibus auxilium ferant, enumerabimus.

Nemo electricitatis peritus ignorat, fluidum electricum excitatum, fluidorum per tubulos Capillares tranſeuntium velocitatem plurimum augere; dehinc plantarum ſuccos et incrementum promovet. Per ſubtilitatem et tenuitatem eximiam ſyſtematis humani vaſa etiam minima pervadit; quapropter crederemus, fluidum electricum, cum per ſyſtema copioſe tranſit, fluidorum per vaſa minima progredientium velocitatem adaugere, abſque cordis et arteriarum auxilio. Nos non fallit haec opinio; electrizatio enim ſimplex

plex vel inſulatio* perſpirationem plurimum auget, et ſudorem copioſum interdum elicit, etſi cordis et arteriarum pulſationes vix accelerat.

Ex hiſce fluidi electrici excitati qualitatibus, nempe, ſubtilitate eximia, per quam corpora ducentia pervadit, velocitate immenſa, qua inter corpora ſemet uniformiter diffundere proclivis eſt, poteſtate qua fluidorum per vaſa etiam minima tranſitum accelerat, et poſtremo, ex proprietate per quam fluida Electricum Fluidum ducunt, Operationis ſuae in Morbis Curandis explicationem conabimur.

Ut inveſtigationem hanc ritu meliori proſequamur, atque ut Theoria noſtra clariori luce appareat, quaedam de indole et cauſa proxima morbi pertinaciſſimi, (nempe Paralyſeos), in quo ſublevando electricitatis vires experientia apprime ſanciuntur, in medium proferamus neceſſe eſt.

Paralyſis pro ortu ſuo duas agnoſcit cauſas proximas diſſimiles, ſcilicet, ſyſtematis

* Abbe Nollet, Phil. Tranſ. V. 10. 384.

nervei Compreſſionem, et ſtatum qui Collapſus vocatur. Electricitas Paralyſin ex collapſu pendentem tantum tollit; at, in pleriſque ex compreſſione originem ducentibus, nocet; collapſus igitur naturam, vel nervorum indolem, ex quo pendet Paralyſis 'ex collap-'ſu dicta,' praecipue indagabimus.

Omnibus patet, ſanguinis circulationem, et vaſorum ſanguiferorum tenſionem, ad Vim nerveam in ſyſtemate vivente gignendam et ſervandam, aeque eſſe neceſſarias; quapropter cerebrum vaſorum numero, et forſan horum diviſione et diſtributione intima, prae caeteris longe eminet viſceribus. Fibrillae porro nerveae ubique vaſculis minimis ſuppeditantur ſanguiferis, et, ſecundum anatomia peritiſſimum Monro ſeniorem, * 'The nervous cords have ſuch numerous 'blood-veſſels, that after their arteries only 'are injected, the whole cord is tinged with 'the colour of the injected liquor.'

Nervos vaſis ſanguiferis energiam ſuam prorſus debere, quotidiana monet experientia; ſic,

* On the nerves.

ſic, vaſorum tenſione per Haemorrhagiam ſublata, ſanguinis per cerebrum et nervos circulatio imminuitur, et vis nervea aequalem patitur diminutionem ; ulterius progrediente ſanguinis effuſione, nervi vi ſua privantur, et, ſi ſanguinis iter per artum qualemcunque impeditur, hoc membrum vim nerveam amittit, et paralyſi brevi corripitur.

Vim nerveam, e contra, ad vaſorum actiones aeque neceſſariam eſſe ſervandas, nemo negabit. Vis autem muſcularis vel nervea arteriarum, per vaſa intervallo longiſſimo ex corde diſſita, ſanguinis circuitum praeſertim promovet ; haec enim ferme nullum ex corde accipiunt auxilium ; quaproper, ſi fibrae eorum muſculares vi nervea privantur, circulationem ſuſtinere non poſſunt : Dehinc, in quibuſdam paralyticis brachio laeſo deorſum pendente ad carpum Arteriarum Pulſationes deprehendes, quae, ſurſum ad perpendiculum brachio elevato, prorſus evaneſcunt ; et in omnibus fere qui hoc morbo tenentur arteriarum radialium pulſationes in brachio paralytico, quam in ſano vel alibi, debiliores ſentiuntur.

ſentiuntur. Quamvis igitur cordis vis integra manet, ſanguis in vaſa membrorum paralyſi laborantium minutiora haud propellitur, et vaſa collabeſcunt.

Quacunque de cauſa paralyſis originem ducit, pars morbo vexata vi nervea orbatur, et motus muſcularis tollitur ; dehinc ſanguinis per membra morbida circuitus plurimum debilitatur, et in vaſis capillaribus, ‘ praeci- ‘ pue nervorum paralyticorum,’ imminuitur, vel prorſus deficit. Tametſi cauſa quae primo paralyſi originem praebuit amoveatur, (ſcilicet cerebri vel nervorum compreſſio), paralyſis nihilominus haud raro permanet, et deinceps ex collapſu pendere fertur ; ex laeſione autem organica, vel partium nervos conſtituentium non conſtat ; electricitate, enim ſaepe ſubito amovetur, quae nervorum dilacerationes ſanare non ſubito poteſt ; collapſus igitur Cauſa Continens aliunde eſt petenda.

Sanguinis circulationem et vaſorum tenſionem, in cerebro praeſertim et nervis, ad ſenſationem et motum conficiendum neceſſarias eſſe ; circulationem quinetiam et vaſo-

rum

rum tenſionem in nervis paralyſi laborantibus penitus deficere, nuper monſtravimus. Quamvis igitur cauſa paralyſeos primaria tollitur, adeo ut nervos quo minus munere ſuo fungantur non amplius impedit, nervis veruntamen aliquid deeſt, ſine quo munera perficere nequeunt, nempe, fluidorum in vaſis ſibi propriis circulatio, quae autem non redintegratur, vi nervea deficiente. Circulationis igitur defectus in vaſis nervorum propriis, paralyſeos ex collapſu cauſam proximam conſtituere videtur.

Plurima morborum phaenomena ſententiae noſtrae veriſimilitudinem ſuppeditant; e. g. * artus ex quibus haemorrhagia profuſa evaſit debiles interdum, vel etiam paralytici, permanſere, licet ſyſtema generale ſanitatem et vires priſtinas recuperaverit. Rheumatiſmus chronicus, artuum extenuatione concomitatus, ex vaſorum debilitate et circulationis defectu manifeſto pendens, paralyſi ex collapſu affinis eſt, et hunc

* Med. Comment. vol. 3. p. 202.

hunc in morbum ſaepe terminat; nervi enim energiam ex vaſorum ſuorum tenſione imminuta amittunt, et haec, tenſionem poſt Haemorrhagiam, &c. propter vim nerveam imminutam, non recuperant.

Si, rationem per quam natura effectus ſedantium vel ſyſtema nerveum debilitantium nocivos praecavet, animo contemplemur, Theoria noſtra probabilitati adhuc conſentanea videbitur. Cauſae debilitantes (ſicut contagium, &c.) ſyſtemati applicatae, ſi fortiſſimae ſunt, vitam ſubito dirimere poſſunt; ſi autem non tantopere pollent, cerebri et nervorum energiam imminuunt, quae energia vix niſi per febrem vel vaſorum actionem creſcentem renovatur; unde jure ſuſpicamus, cerebrum per ſe, ſine vaſorum aucta actione, energiam ſuam reficere non poſſe. Quaedam praeterea, ni fallor, apud auctores narrantur exempla paralyticorum ex morbo febre ſuperveniente ſolutorum, et paralyſis 'a collapſu dicta,' cauſis ex ſedantibus (ſicut venenis, &c.) ſaepe oritur. Iterum, ſiquando paralyticus ex electricitate

tricitate commodum accipit, prima valetudinis ſigna membrorum morbo detentorum molis incrementum cito conſequitur, quod nutritionis acceſſioni, quam fluidorum per artus circulantium augmini, non tantopere tribuamus.

Ex hiſce et plurimis aliis obſervationibus, nequaquam ambigi videtur, quin nervi ex vaſibus ſibi propriis aliquid, aeque ac cerebro, energiae ſuae neceſſarium accipiunt, ſine quo munere ſuo fungi non poſſunt.

Cum ſyſtema ſanguiferum et nerveum in ſeſe mutuo agunt, et pro energia invicem alii aliis nituntur, ſi utriuſvis energia abolétur, alterius etiam deſinere oportet; neque cujuſvis vires reſtitui poſſunt, donec omnia quae reactioni obſtant ſublata ſint, et motus vel actio in ſyſtemate alterutro inchoatus fuerit. Nervi autem, ſine quodam accepto ex vaſis ſanguiferis auxilio, operationes ſuas nec incipere, neque inceptas ſervare, poſſunt; quamvis enim ex Cerebro aliqúid ſenſationi ac motui ut rite perficiantur neceſſarium, ex Vaſis etiam ſanguiferis ſibimet propriis hiſce

functionibus aeque neceſſarium aliquid accipiunt. Vaſa e contra energia nervea orbata fluida per ſe propellere non valent; nervi idcirco a vaſis id cujus indigent non obtinent.

Electricitas (ſicut ſupra obſervavimus) qualitate fruitur peculiari fluida per tubulos, et praecipue capillares, celeriter devehendi: Cum ergo fluidum electricum excitatum corporis vaſa minima pervadit, fluida per vaſa minima ſecum properat, et eorum lumina amplificat; haec iterum elaſticitate praedita ſimplici contrahunt. Hiſce reiteratis, vaſorum actiones et fluidorum circuitus renovantur, nervi ex vaſis quicquid egent ad energiam ſuam recuperandam accipiunt. Energia nervea, eo modo renovata, fibris vaſorum muſcularibus impertitur, quae iterum circulationem per fluidum electricum inceptam ſervant, atque ita vis nervea ſtabilitur et paralyſis amovetur.

Si energia nervea tam per vaſa nervorum, quam cerebri corticem, quaquaverſum ingredientia

dientia ſecernitur, ſicut* MONRO celeberrimus ‘ ferme procul dubio’ comprobavit, doctrina noſtra eo clarior reddetur; nam, ſi circulatio per nervos paralyſi affectos (quod monſtrare conati ſumus) prorſus vel ferme impeditur, energia nervea nequaquam ſecerni poteſt; quamprimum autem Electricitate circulatio renovatur, energia nervea iterum ſecernitur, qua rurſus circulatio ſervatur.

1*mo*, Nonne pendet morbi repentina ſublevatio, quae ab Electricitatis uſu paralyticis interdum accidit, ex ſanguine fluidum per electricum ad nervos provecto? Nonne etiam ſenſus et motus abolitio, ſaepe poſt Electricitatem praemature deſertam eveniens, a circuitu rurſus deficiente pendet, propter energiam nerveam haud uſque adeo renovatam ut vaſorum actiones ſuſtentare queat?

2*do*, Nonne pendet artuum paralyticorum incrementum magnitudinis velox, quod

* Praelectiones anat.

dum aeger utitur Electricitate locum habet, ex fluidis in vaſa artuum capillaria per fluidum electricum devectis? Nonne igitur artuum paralyticorum decrementum ex fluidorum circulantium inopia et vaſorum collapſu, plus quam ex vero nutrimenti defectu, pendet? Quod, ſi conceditur, argumentum hoc, Nutritionem per nervos perfici veriſimile faciens, funditus ſubvertit.

Electricitas fluorem menſtruum cito, interdum etiam dum electrizatur aegra, adigit, quod niſi accidit *Leucorrhoea* levis primo allicitur, et poſthac menſtrua erumpunt. Hoc iiſdem pendet ex principiis, nempe, fluidorum in vaſis minimis acceleratione et ſecum tranſlatione, eo modo fluidum electricum vaſorum Uteri, ex quibus profluit fluor menſtruus, lumina extendit. Forſan quibuſdam in exemplis fluidum electricum, aeque vaſorum ac uteri ipſius, ſpaſmos ſolvit; cum autem ſtructurae qua muſculus ſeſe contrahere pollet, noſmet prorſus ignaros fatemur, operationem ſuam in ſpaſmis ſolvendis nequaquam explicare aggrediemur.

Eodem

Eodem modo Calculorum ex ureteribus propulſio exponitur. Calvitiem quinetiam amovet, fluidorum, per glandulas crines ſecernentes, vel crinum bulbos, circulationem promovendo.

Obſervationibus de Electricitatis in morbis tollendis Operatione peractis, de Morbis in quibus cum utilitate jam adhibita fuit, et de hiſce quibus tempore futuro Theoria noſtra ſolamen pollicetur, nunc dicendum eſt; et imprimis,

DE FEBRIBUS.

Electricitas Febres curavit Intermittentes*; Weſley tertianas et quotidianas, et† Lindhoult quartanam pertinaciſſimam, electrizatione amovebant. Intermittentes ex cerebri energia imminuta pendent, et quicquid ſyſtematis tonum ſuppeditat vel reficit, paroxyſmos impedit, morbumque amovet; dehinc

* Deſideratum.

† Memoire ſur maux gueris par elect. vide Med. Com. v. 1. p. 372.

dehinc verisimile videtur, electricitatem morbum sufferre fluidorum circuitum per vasa cerebri et nervorum promovendo, atque ita energiam nerveam renovando. Nonne eodem modo Febres Continuas, praecipue Nervosas dictas, subito tolleret? *Insulatio* saltem tuto hisce adhiberi posset.

†CYNANCHEN TONSILLAREM abstulit; hic, mehercule, quodammodo stimulo topico solamen retulit; scintillae enim ex partibus vicinis extractae erant, et sat compertum habemus, stimulos, parti inflammatione vexatae proximae applicatos, inflammationem imminuere; forsan autem aliquid commodi ex fluidi electrici subtilitate emanabat, spatio enim temporis minimo morbum abripiebat.

RHEUMATISMUS CHRONICUS maximum ab electricitate accepit auxilium. Ex variis hujusce morbi phaenomenis, pro Causa Proxima, circulationis in vasis minimis defectum et horum irritabilitatem, cum majorum debilitate, agnoscere nobis videtur. Eo ut hancce ideam

† Ferguson's introd. p. 125.

ideam probabilem reddamus, cauſas remotas, ſymptomata, ſequelas, et morbi medelam, ſpectemus.

Pro Cauſa Remota vaſorum partis affectae actiones pernimium et diu auctas, quod in Rheumatiſmo locum habet acuto, vel diſtortionibus articulorum ſubitis, vel contuſionibus, Rheum. Chron. plerumque fatetur; muſculorum autem exercitatio nimis diu protracta, vel conatus vehementes horum debilitatem inferunt ; debilitas quinetiam irritabilitate ſaepe comitatur, praecipue poſt Phlegmaſiam.

Symptomata ſunt *pallor* et *frigiditas* partium morbo detentarum, quae circulationem debilem oſtendunt ; corporis enim calor ad ſanguinis circuitum palam alligatur arctiſſimo nexu. Partium harum *ſiccitas*, etſi corpus alibi ſudore manat, ſanguinem in vaſa minima non propelli demonſtrat. *Articulorum* rigor, crepitatio et dolor, ſi quando moventur crura, ſynoviae vel liquorum juncturas lubricantium inopiam indicant. *Artuum extenuatio* eadem ex cauſa (nempe circuitus in vaſis minoribus defectu) pendet.

Dolores

Dolores ſaevi quibus aegri, poſt temperiem vel aëris gravitatem ſubito mutatam excruciantur, vaſorum irritabilitatem monſtrant, ob quam diſtenſiones vel contractiones ſolito majores aegre ferunt.

Sequelae ſunt juncturae immobilitas, vel interdum anchyloſis, ex cartilaginum abolitione, et paralyſis ex collapſu, cauſas olim deſignatas agnoſcens.

Medela efficitur per medicamenta, 1*mo*, quae ſyſtematis tonum revocant, et eo modo irritabilitatem amovent; horum exempla ſunt cortex Peruvianus et balneum frigidum. 2*do*, Quae ſanguinis per vaſa circuitum promovent, dehinc rigorem, &c. tollunt; inter haec ſunt ſtimulantia, frictio quae fluidorum circulationem mechanice promovet, et exercitium. Dehinc colligimus, fluidum electricum Rheumatiſmum ſublevare Chronicum, ſanguinis per vaſa debilitata circuitum promovendo, eo modo vim nerveam et muſcularem renovando. Nonne *Penicilla* in rheumatiſmo acuto commodo, praecipue poſt venaeſectionem, adhiberi poſſent?

AMENTIA

AMENTIA Phrenitidem interdum ſequitur, et ex circuitus, in vaſis cerebri inflammatione praegreſſa debilitatis imminutione, quibuſdam in exemplis pendere videtur. Hic *a priori* expectemus inſulationem, circuitum promovendo per vaſa minora, et forſan ſcintillas vel penicilla partibus cerebro vicinis abſtracta, prodeſſe.

PARALYSIS.

De electricitatis utilitate hoc in morbo alibi locuti ſumus; et ab antedictis ſpei locus eſt, ſi paralyſis ex collapſu pendebat, electricitatem utilem fore. De Haen*, qui maxima ſedulitate et conſtantia, ac qui electrizatione ſimplici vel inſulatione plurimum uſus eſt, plurima ſucceſſus refert exempla; a† Saunders quinque narrantur paralyſeos caſus per electricitatem curati, qui aliis nullum acceperunt remediis ſolamen, et ‡Brydone mulieri, quae per ſex menſes Hemiplegia detenta

* Ratio Medendi. † Medical Commentaries, vol. 3.
‡ Whytt's Works.

tenta fuerat, ſanitatem intra triduum reddidit.

DYSPEPSIA a ventriculi muſculorum debilitate, et energia imminuta ex confeſſo pendet; electricitate ergo forſan levari poteſt; inſulatio ſecretiones promovet, unde Digeſtionem liquoris gaſtrici copiam augendo adjuvaret. Cum nexus perſpirationem inter et cibi appetentiam arctiſſimus locum habet *, eo ut quicquid perſpirationem promovet, cibi deſiderium plerumque acuit, electricitatem ſimplicem vel inſulationem Anorexiam amovere, perſpirationem cum promovet, ſtatuamus; et †L'Abbe Nollet, qui juvenes per horas quinque ſimul electrizavit, cibi eorum appetentiam acui obſervavit; ‡Ferguſon, denique, gaſtrodyniam per ſuccuſſus electricos amovebat.

Cum fluorem menſtruum excitat, forſan etiam CHLOROSI prodeſſet.

SPASMI electricitatis uſu ſaepe ſolvuntur; cum autem olim obſervavimus noſmet, quali ſtructura

* Cullen's Firſt Lines, p. 33. Sydenhami Opera, 125, 6.

† Prieſtley on Electricity, 137. ‡ Introduction.

ſtructura muſculo ſeſe contrahendi vires ſuppeditantur, prorſus ignorare, pauca tantum proferemus exempla ſpaſmorum electricitate ſolutorum, et morbum unum alterumve ſubjungemus, in quibus, a priori, electricitatis ex uſu commodum expectemus.

TETANUS et TRISMUS inter ſpaſmos imprimis, aeque ob periculum quod aegro minitatur, ac ob pertinacitatem qua remediis obſtant valentiſſimis, recenſeri merentur. Dr Watſon tetanum ex puella ſeptem annos, et Dr Spry triſmum ex altera octodecim annos nata, electricitate ſuſtulit.

*De Haen CHOREAM St VITI electricitate ſaepe curavit; †Lindhoult epilepſiam, et ‡Weſley hyſteriam ſuſtulit. Ex hiſce operae pretium fore duco virium electricorum in §ASTHMATE SPASMODICO, in Pertuſſi, Colica, et Hydrophobia periculum facere.

* Ratio Medendi. † Medical Commentaries, vol. 1. 373.

‡ Deſideratum.

§ Mulier quae febre intermittente irregulari laborabat, aſthmate correpta erat: Illuſt. Dr HOPE electricitatem adhiberi

Experimenta plurima electricitatem aërem atmoſphaericum in fixabilem convertere oſtendunt, hoc a phlogiſton, e quo conſtat, vel ſaltem quod copioſe continet, pendet: Dehinc probabile videtur, quod Tympanitidis et Emphyſematis curationem plurimum adjuvaret, aëris abſorptionem promovendo; in ſtatu enim aëris fixabilis ſolum per vaſa lactea abſorberi aër videtur. Inſulatio vel penicilla diu adhibita commodum hic pollicetur. Forſan anaſarcam amoveret, et rachitidi prodeſſet. * Contracturam ſaepiſſime abſtulit, fluidorum lubricantium et ſynoviae ſecretionem promovendo.

AMENORRHOEAM viribus electricis fere ſemper vinci, olim obſervavimus.

Gutta

adhiberi juſſit, quae aſthma ſubito amovebat, et intermittentis ſtadium frigidum inducebat. Paroxymo finito, aſthma iterum ſuperveniebat, atque ſecundo electricitate fugato intermittentis paroxyſmus redibat. Haec ſucceſſu pari ſaepius reiterata erant. Edin. Infirmary regiſter, 1771.

* Lindhoult, Medical Commentaries, vol. 3. 371. Jallabert, p. 7, on Electricity, &c.

† Gutta ſerena, Odontalgia, Dyſecoea, Schirrus, et plurimi alii morbi, electricitate ſublati fuerunt.

‘ Decipimur ſpecie recti, brevis eſſe laboro,
‘ Obſcurus fio : Sectantem gravia nervi
‘ Deficiunt animique.

Horat. de arte Poetica.

† Hey ſeptem narrat caſus aegrorum ex amauroſi electricitatis uſu ſolutorum. Lond. Med. Obſ. vol. 5. p. 1. 25.

FINIS.

TRANSLATION

BY

REV. F. R. STEAVENSON

AN INAUGURAL MEDICAL DISSERTATION

UPON

ELECTRICITY, AND ITS MANNER OF WORKING IN THE TREATMENT OF DISEASE:

WHICH

BY THE FAVOUR OF THE SUPREME BEING,
AND BY THE AUTHORITY OF THE VERY REVEREND

D. WILLIAM ROBERTSON, D.D.
PRINCIPAL OF THE UNIVERSITY OF EDINBURGH;

AND ALSO

WITH THE CONSENT OF THE MOST HONORABLE SENATUS ACADEMICUS,
AND BY THE DECREE OF THE MOST DISTINGUISHED FACULTY OF MEDICINE,

FOR THE DEGREE OF DOCTOR,

AND THE HIGHEST HONOURS AND PRIVILEGES IN MEDICINE
RIGHTLY AND DULY APPERTAINING THERETO;

ROBERT STEAVENSON, AN ENGLISH M.A.
FELLOW OF THE MEDICAL SOCIETY AND ALSO
HON. FELLOW OF THE SOCIETY OF PHYSICIANS AND SURGEONS.

SUBMITS TO THE CONSIDERATION OF THE LEARNED.

* "Nought is too high for the daring of mortals.
Heaven's very self in our folly we storm.
Never is Jove, through our guilty aspiring,
Suffered to lay down the bolt we provoke."
ODES OF HORACE.

ON THE 24TH DAY OF JUNE AT THE USUAL HOUR AND PLACE.

EDINBURGH:
BALFOUR AND SMELLIE,
PRINTERS TO THE UNIVERSITY.
1778.

* Lord Lytton's 'Horace.'

To that most accomplished young man

WALTER OGILVY, Esq.,

Eldest son of

Sir John Ogilvy of Innerquharity, Bart.,

Who was beloved by all

On account of his courtesy,

And especially by him, owing to the close friendship

Which bound them together

While they pursued the study of Philosophy

For three years at St. Andrew's University;

Also

To the most distinguished Senator,

JAMES WILKINSON, Esq.,

Who is equally esteemed

Whether in the management of

Public or private affairs,

And noted not only for the grace of his manners,

But also for the uprightness of his life;

And, lastly,

To the most learned

JOHN BURN, M.D.,

Who practises

Apollo's art at Berwick

With the greatest credit to himself

And benefit to his fellow-townsmen,

Who is ever deserving of respect and honour

Both on account of the medical knowledge

Derived from him

While for three years under his guidance

He visited very many patients,

And also on account of

The advice and friendship

With which he honoured him

Whilst for four years he applied himself

To the study of Medicine

In the University of Edinburgh,

THE AUTHOR

Gladly Dedicates these firstfruits

Of his studies.

AN INAUGURAL

MEDICAL DISSERTATION

ON

ELECTRICITY AND ITS MANNER OF WORKING IN THE TREATMENT OF DISEASE.

Just as man advances slowly and by degrees from the rude state of barbarism to cultivation and civilisation, so philosophy moves on from the first faint glimmer of dawn to the perfect light of day. In one century, some chance circumstance or some profound intellect gives birth to various arts and sciences, and the industry and experience of succeeding centuries brings them to a high state of perfection. Though, in my opinion, the ancients were by no means inferior to the moderns in intellect, still the moderns by adding their experience

to the others' knowledge, have far outstripped them in very many departments of science, and especially in Physics.

As science advanced thus gradually to a state of cultivation, electricity was brought into prominent notice only within the present century. For though the ancient writers used to speak of bodies which after friction were endued with the power of attracting lighter bodies to themselves, they were nevertheless entirely ignorant that this power depended upon a fluid now called the "electric" fluid. The lightning was formerly considered to be sacred to God Himself, and the scourge of impious men; but to-day it is well known to be distributed throughout the mundane system, and to bring healing to the diseased; for it is produced by the electric fluid, which may be drawn from the earth and clouds alike, and can simulate every appearance of the lightning.

It is now well known that this fluid produces very many phenomena, which the philosophers of the last century were altogether unable to account for. For our "savants" have proved that the Aurora Borealis, earthquakes, whirlwinds,

meteors, &c., are produced entirely by the electric fluid.

Electricity furnishes us with many phenomena, which would have been better calculated to amuse and interest the mind than to add to the comforts of life, if that most talented man Franklin, and Jallabert, had not happily and successfully turned their knowledge of the powers of electricity, the one to combating the danger of lightning-strokes, the other to the cure of disease. Still though very many of the effects of electricity are well understood, we may boldly assert that many are as yet enveloped in obscurity.

Although it is conceded that electricity holds a place among the most efficacious remedies of the day, the forces by which it removes disease from the human body are not thoroughly understood; and so it is used somewhat empirically. I have determined therefore to explain, as well as I possibly can, its Modus Operandi, and then to enumerate the diseases in the cure of which it is most likely to prove efficacious. In the first place, however, a few words must be said about the

WAYS OF APPLYING IT.

The electric fluid possesses very many extremely wonderful qualities, a few of which I will

mention as especially worthy of our attention, because they help to explain the method of its application, and perhaps of its action.

1st. It pervades the terrestrial system in every part, so that all bodies have a certain quantity as it were concealed in them; and thus it is that bodies are said to be charged with electric fluid, and the electric fluid is said to be in equilibrium and at rest.

2nd. The equilibrium and the rest are disturbed by the friction of certain bodies, *e.g.* a glass cylinder, &c., and then it is said to be in motion.

3rd. It can be drawn out of some bodies and conveyed elsewhere, in others it can be accumulated and intensified, and in all its position can be shifted. Hence with reference to the electric fluid, bodies are divided into two classes, viz. the Exciting, which are called *electric*, and the Conveying, which are called *Conductors*. To the latter class belong metals, fluids or moist substances, charcoal, and vitreous substances; nearly all other bodies are reckoned among the electric. Moreover, it must be observed that substances which excite the electric fluid

do not attract it, and for that reason they are called *non-conductors*, and those which attract do not excite, and therefore they are called *non-electric*.

4th. Whenever equilibrium is disturbed, *e.g.* if the electric fluid is accumulated in any substance, or is taken away from any substance, or is accumulated and intensified in one part or surface of any substance, whilst it is taken away from the other surface (which happens in the experiment of the Leyden jar) immediately on the application of a conductor, equilibrium is restored with infinite and almost incredible speed.

5th. It invariably prefers some conductors to others, though it should have to go a long way out of the direct course; for instance, it prefers metals to charcoal, and charcoal to fluids; but, *cæteris paribus*, it seeks equilibrium by the nearest way.

6th. It is possessed of an extraordinary power of penetration and mobility, so that it very readily passes through conductors, and fastens upon *electric substances* (*e.g.* on glass, &c.), though it does not pass through them.

As a consequence of these properties of electricity there are three methods of applying it to the human body, by one of which,

namely *Insulation*, the electric fluid, aroused by the application of an electric substance, is prevented from passing to surrounding bodies, and therefore necessarily becomes accumulated in the human body. Whilst this operation is being performed, the electric fluid penetrates all the inmost recesses of the body, and gradually, with greater or less speed, according to the humidity or dryness of the air, passes through each pore to the outer air, and takes fluid substances with it. This method of application shows the natural qualities of the electric fluid when excited, largely increases the perspiration, somewhat quickens the action of the heart and arteries, often produces sweating, and promotes all the secretions.

If to a body which has been insulated and unduly charged with electric fluid which has been excited, a *Conductor* is suddenly applied, the superabundant fluid makes for it with the greatest speed, and (if the conductor be not a sharpened one) with difficulty leaves the body in the form of a luminous spark, and gives pain and a redness to the part by the shock; or if any part of the human body is applied to a conductor which is insulated and charged with fluid it receives the spark

and the shock. The former of these methods produces almost the same effects as Insulation, combined with a local and mechanical stimulus, the latter does little more than give a local and mechanical stimulus. If therefore we wish to affect the body generally as well as to give a local stimulus, the *spark* must be drawn from the patient after he has been insulated; but if on the other hand we only wish to give a local stimulus, the spark must be applied to him without his being insulated.

If the fluid is accumulated and intensified upon one surface of a body called "*naturally electric*," *e.g.* a sheet of glass or a glass phial, it is driven from the other surface in an equal degree, for electric bodies can only contain their natural quantity of the fluid, though its position or distribution can be altered; therefore we should say that on one surface the fluid, on the other the solid part predominated. But directly a communication is established between the two surfaces by the application of a conductor, equilibrium is restored with greater or less speed according to the nature of the surface, the condensation of the electric fluid, and the perfectness of the conductor, and it is restored with a sharp shock, for the speed and shock of the electric fluid

is increased by condensation, like those of other fluids which possess the power of resilience. Whilst the electric fluid is accumulated upon one surface of the glass phial or sheet of glass, it is said to be *Charged*, and if a human body (which does not conduct the electric fluid except by the aid of moisture) should establish a communication between the two surfaces, equilibrium is restored through the body, the body receives a very sharp shock or *Shaking*, and the phial is said to be *Discharged*. This is called a *Shock*, and under this method of applying the fluid it pervades only a part of the system, but it pervades that part with the greatest speed, for it endeavours to attain equilibrium and an equal diffusion by the most direct way.

As regards then the application of electricity to the body, Insulation may be used in very many diseases without danger, and in many with advantage: Shock in only a few, and in these often with the greatest prudence. Sparks more frequently than Shock, less frequently than Insulation, may be allowed to be used.

Whilst I was thinking over the property of sharpened conductors, that is their power of suddenly drawing the electric fluid

which has become accumulated out of bodies silently and without a spark, a fourth method of applying it, which promises to be advantageous, occurred to my mind, and which, to distinguish it from the others, I would call *the Pencil Method.* It is very well known that pointed instruments strongly attract the fluid when once excited; if therefore to an insulated human body, unduly charged with electric fluid, a pointed conductor be applied, the superabundant fluid will be drawn out, without a shock and at the same time without causing pain, from this part in the form of a luminous pencil; whereby the volume and speed of the fluid as it passes through whatever part we desire may be greatly increased, and if we enlarge the space through which the fluid makes its escape, it will only be necessary to increase the number of the points. I have at present made no experiments, though I have it in my mind to set some on foot in connection with this; for it seems probable to me that it might be very useful in dispersing scirrhous tumours, in which we should seek to prevent suppuration above all things; it might be applied with advantage perhaps even in some forms of Inflammation.

Before we bring this part of the dissertation to a close, it must be observed, that doctors seldom persevere in the use of electricity with sufficient diligence; for we ought not to forget that, though electricity removes some diseases all at once and as if by magic, still in others it must be used with long patience; and though the patient may have received no benefit from it after two or three months' use, still success is by no means to be despaired of; for it has removed, even after six months, diseases which could not be cured otherwise.* But Shenstone said, "Patience is a panacea; but where is it to be found, and who can swallow it?"

ON ITS MODE OF ACTION.

From these remarks on the modes of its application, we may conclude that the action of electricity will be different according to the difference of its application; and we have it on record as a well-known fact, that an excessive shock just like violent blows has entirely destroyed life, while gentler applications have

* De Haen, 'Science of Medicine.'

restored to life the torpid and half-dead limbs.

With respect to its Mode of Action learned men are divided into two parties, one of which will have it that electricity acts simply as a stimulus, while the other endeavours to prove by many arguments that the electric fluid is the cause of sensation and motion in living bodies, in other words that it is the same as the Nervous Fluid ;* and hence, they believe that the electric fluid cures paralysis, by increasing the quantity of nerve force, and removing impediments in its course.

We must first speak of the former of these opinions ; and in order that we may inquire properly into its truth, let us look at the effects of stimulants such as electricity, upon certain diseases.

Stimulants act only upon the nerve or sentient fibres, a fact which is due to the sensitiveness of the nerve and its intolerance of certain sensations ; and hence they increase both in frequency and force the contractions of the muscles, especially of those which are connected with the circulation of the blood ; therefore they produce no effect in the first instance

* Deshais, ' Extracts from Montpellier.'

upon the non-sentient fibres, except in so far as they draw them into wrinkles or furrows by their pungency.

Electricity, on the other hand, is good for Paralysis; but its stimulating powers will not explain the phenomena in this case; for it arouses a nerve which has neither sensation nor power of motion, and therefore not capable of stimulation, and of this nerve it restores the sensitiveness and powers.

Electricity removes Amenorrhœa, and very frequently has re-established the monthly discharge of the weaker sex which is so essential to their health, so much so that Franklin, who has made use of electricity many times in this complaint, declares that it has seldom belied his expectations. But Amenorrhœa very often obstinately resists the most powerful stimulants, and baffles the efforts of the doctors; thus wine and exercise quicken the action of the heart and arteries more than electricity does; if therefore effects of this kind depended upon stimulus alone, wine, &c., would be better calculated to bring about the desired result, but experience does not confirm this.

Scirrhous tumours* are sometimes dispersed by the electric fluid, but not at all by its stimulating power; for suppuration would have to be feared as the result of a stimulus, and as a matter of fact electric sparks which chiefly stimulate do hasten on suppuration.

Electricity accelerates the passage of calculi† through the ureters, whereas stimulants would rather hinder it, for whatever irritates the ureters brings on spasms and narrows the calibre of the ureter and therefore would be avoided by us in treating that disease.

The application of electricity removes baldness‡ and promotes the growth of the hair, effects which can scarcely be attributed to any stimulating power.

Hence it seems just for us to conclude that although we may not deny to electricity when applied in a certain manner, a mechanical stimulating power, which is the result of its own momentum, still other properties must be taken into the calculation of its mode of action, in order that we may be able to determine the lines upon which it works, to lay down adequate indications of its working,

* 'Med. Comment.,' v. 4, p. 82.

† 'Wesley's Desideratum.'

‡ 'Carmichael, Tentamen,' p. 33.

and to say beforehand in what diseases benefit is to be expected from its use.

Since therefore we have shown, that this theory about electricity is insufficient to explain these effects, let us carefully examine the opinion put forth by Deshais, and consider the arguments which he brings forward in support of his opinion.

1st. He says, that the striking together of fluids and solids excites the electric fluid which naturally lies latent in the bodies of animals, and that this is made clear by a certain property of the furs of animals; for if their hairs be rubbed in the dark, the electric fluid is clearly seen passing from them. But it must be observed that this does not depend on any power peculiar to living animals, but that it is excited by the friction of an *electric body* (to wit the fur of animals).

2nd. He declares that the nerves conduct the electric fluid in preference to other parts of the system; because, if you apply electricity to a living dog, after you have laid bare and cut the great nerve, luminous rays are thrown forth from the nerve. This again depends not on the inner substance of the nerve, but on the moisture by which it is concealed, and on the powers of sharpened

instruments which we mentioned just now. The nerves act as conductors of electricity but imperfectly.*

3rd. He thinks that the electric fluid or (what according to him is the same thing) the nerve fluid does not return to the brain to communicate the sensation of Touch, but passes to the body which we touch. But to this we answer, that bodies which possess an equal quantity of the electric fluid do not pass their electricity the one to the other, but the electric fluid is equally spread among bodies which are in contact with electric substances, and under these conditions shows no signs of electricity; therefore, when matters are thus, we can neither feel our own body nor neighbouring bodies.

Moreover, it must be observed, that the nervous energy is altogether destroyed, whether the nerve be bound up in a *conductor* or an *electric substance*. In fine, the argument which totally overthrows this theory still remains; for if this theory were to be accepted as true, and we were to draw the natural electric fluid out of the living system,

* I have found by experiments that dry and withered nerves do not perfectly conduct the electric fluid, but that nerves in full vigour do so easily, though scarcely so well as the whole body

we should also destroy the nerve power, and if we partially diminish the nerve power according to a certain proportion the case becomes altogether different.

Having therefore rejected these theories, let us cautiously and with diffidence take in hand the method in which electricity works, and bring forward our own idea on this subject; but in the first place let us enumerate certain properties of the electric fluid which may help us in our investigations into its action upon the human body.

No one who knows anything about electricity is ignorant of the fact that the electric fluid when excited very greatly increases the speed of the fluids passing through hair-like tubes, and hence it promotes the flow of sap and the growth of plants. Owing to its extreme fineness and delicacy it pervades even the smallest vessels of the human system, wherefore we may believe that the electric fluid, passing as it does freely throughout the whole system, increases the speed of the fluids which pass through the smallest vessels, independently of the help of the heart and arteries. This opinion does not escape our notice; for the application of electricity pure and simple

or insulation* very greatly increases the perspiration, and sometimes induces copious sweating, though it scarcely accelerates at all the action of the heart and arteries.

Having stated these properties of the electric fluid when excited, that is, its extreme fineness, by which it spreads through bodies which are conductors, its vast speed, with which it is prone to diffuse itself uniformly amongst bodies, the power with which it accelerates the passage of fluids even through the smallest vessels, and lastly the property owing to which fluids conduct the Electric Fluid, and starting with these as our basis we will endeavour to explain its Action in the Curing of Disease.

In order that we may prosecute this investigation the better, and our Theory may stand forth in a clearer light, it is necessary to state certain things concerning the nature and proximate cause of that most obstinate disease, Paralysis, in the relief of which the powers of electricity have by experience been found largely useful.

There are two acknowledged but dissimilar proximate causes which lead to paralysis, viz. Compression of the nervous system and

* Abbé Nollet, 'Phil. Trans.,' v. 10, 384.

the condition which is called Collapse. Electricity only removes the Paralysis which follows upon collapse; and is hurtful in most cases of that disease which result from compression; we shall therefore especially investigate the nature of the collapse, or the condition of the nerves from which Paralysis "from collapse" results.

It is evident to all that the circulation of the blood and the tone of the sanguiferous vessels are equally necessary for creating and maintaining nerve force in the living system; for which reason the brain far surpasses all the other viscera in the number of its vessels and probably in their minute division and distribution. Moreover the nerve-fibres are supplied in all directions with very minute vessels, and according to that eminent anatomist the elder Monro* "The nervous cords have such numerous blood-vessels, that after their arteries only are injected, the whole cord is tinged with the colour of the injected liquor."

Daily experience tells us that the nerves owe all their energy to their blood-vessels;

* 'On the Nerves.'

thus, when the tone of the vessels has been lost owing to Hæmorrhage, the circulation of the blood through the brain and nerves is impaired, and the nerve force sustains a corresponding loss; if the loss of the blood continues, the nerves lose their power, and if the flow of the blood through any limb is impeded that member loses its nerve power, and becomes paralysed for a time.

No one will deny, on the other hand, that nerve power is necessary for maintaining the action of the vessels. The muscular or nerve power of the arteries is the chief thing which promotes the flow of the blood through the vessels the furthest remote from the heart; for they receive scarcely any help from the heart itself; wherefore if their muscular fibres be deprived of nerve power, they cannot keep up the circulation: Hence in some paralytics you will detect the pulsation of the arteries to the wrist while the affected arm is hanging down, but when the arm is raised to the perpendicular it altogether disappears; and in almost all who are suffering from this disease the pulsations of the radial arteries are found to be more feeble in the paralysed limb than in the sound one or elsewhere.

Wherefore although the power of the heart remains unimpaired, the blood is not sent into the smaller vessels of the limbs of paralytics, and accordingly the vessels collapse.

From whatever cause paralysis springs, the affected part is deprived of nerve power and muscular motion is lost; hence the flow of blood through the dead limbs is very greatly weakened, and in the capillary vessels, especially of the paralysed nerves, it is impaired or fails altogether. Still though the cause which first gave rise to the paralysis be removed (viz. compression of the brain or nerves) the paralysis itself nevertheless not unfrequently remains, and then it is said to be the consequence of collapse, whether arising from some organic injury, or injury of the parts which regulate the nerves, it is not certain; for it is often removed all at once by electricity, which cannot all at once heal the laceration of the nerves; wherefore we must look elsewhere for the moving cause of collapse.

We pointed out a little time ago that the circulation of the blood and tone of the vessels, especially in the brain and nerves, are necessary for producing sensation and motion; and that the circulation and tone of the vessels

is altogether wanting in paralysed nerves. Though therefore the primary cause of paralysis be removed, so that it no longer prevents the nerves from performing their proper functions, still something is wanting to the nerves without which they cannot perform their functions, viz. a circulation of fluids in their own vessels which is not restored as long as the nerve force is wanting. The want therefore of circulation in the vessels of the nerves themselves, appears to constitute the proximate cause of paralysis from collapse.

Very many phenomena of diseases present to our minds the appearance of reality, e. g. *limbs from which excessive hæmorrhage has taken place have sometimes remained weak, or even paralysed, although the general system has recovered its health and former strength. Chronic rheumatism, accompanied by wasting of the limbs, and resulting from weakness of the vessels and evident want of circulation, is closely akin to paralysis from collapse, and

* 'Med. Comment.,' vol. 3, p. 202.

often ends in that disease; for the nerves lose their energy owing to the tone of their vessels being impaired, and these do not recover their tone after hæmorrhage, &c., owing to the nerve power being impaired.

If we consider the way in which nature guards against the harmful effects of things which lower or weaken the nervous system, our Theory will still seem consistent with probability. Weakening causes (like contagion, &c.), when applied to the system, if they are very intense, are able to kill outright; but if they are not so powerful as that, they impair the energy of the brain and nerves, which energy is with difficulty restored except by fever and the increased action of the vessels; whence we may justly suspect that the brain alone, without the increased action of the vessels, cannot restore its own energy. And more than this, there are, unless I am mistaken, some examples recorded by medical writers of paralytics being cured of their disease on fever supervening, and paralysis from collapse often arises from lowering causes (such as poisons, &c.). Again, whenever a paralytic

receives benefit from electricity, increase in size quickly follows the first signs of returning health in the members affected by the disease, an increase which we are to attribute not so much to an accession of nourishment as to an increase of the fluids circulating through the limbs.

From these and many other observations there seems to be no doubt that the nerves receive something from their own vessels, equally with the brain, which is essential to their energy, and without which they cannot discharge their proper functions.

Since the arterial and nervous systems act and re-act on one another, and in turns strive for energy, if the energy of either is destroyed the energy of the other must also cease; neither can the powers of either be restored, until everything which hinders a re-action has been removed, and motion or action has been set on foot in one of the two systems. For the nerves, are able neither to commence their work, nor to keep it up when once begun, without some help from the blood-vessels; for although they receive from the brain something which is required for the proper development of sensation and motion, they receive also from their own blood-vessels

something which is equally essential to these functions. The vessels on the other hand if deprived of nervous energy are not able to send fluids through themselves; so the nerves do not obtain from the vessels that of which the latter are in want.

Electricity (as we have observed above) possesses the peculiar property of swiftly conveying fluids through small tubes, and especially through capillary tubes. When therefore the excited electric fluid pervades the smallest vessels of the body, it accelerates the passage of fluids through the smallest vessels, and enlarges their openings; which again contract owing to their mere elasticity. And on this being repeated, the action of the vessels and the circulation of the fluids are restored, and the nerves receive from the vessels whatever they need for recovering their own energy. The nervous energy, thus restored, is imparted to the muscular fibres of the vessels, which keep up the circulation again set on foot by the electric fluid, and thus nerve power is established and paralysis is removed.

If nervous energy is discerned as much by the vessels of the nerves, as by those which enter the cortex of the brain in every direction

as that most eminent man *Monro proves almost without a doubt, our theory will become all the clearer; for, if the circulation is altogether or almost stopped (as we have endeavoured to show) owing to paralysed nerves, the nervous energy can by no means be discerned; but as soon as the circulation is restored by electricity, the nervous energy is again discerned, and by it the circulation is a second time kept up.

1st. Does not the sudden relief from their complaint, which paralytics sometimes experience owing to the use of electricity depend upon the blood which has been imparted to the nerves by the electric fluid? And does not also the failure of the power of feeling and motion, which often occurs when electricity has been prematurely abandoned, result from the circulation once more being wanting, owing to the nervous energy not being sufficiently restored to maintain the action of the vessels?

2nd. Does not the rapid increase in size of the paralysed limbs, which occurs whilst

* 'Lectures on Anatomy.'

the patient uses electricity depend upon the fluids which are carried by the electric fluid into the capillary vessels of the limbs? And therefore does not the decrease of the paralysed limbs depend upon the want of circulating fluids and the collapse of the vessels, rather than upon real want of nourishment? And if this be conceded, it altogether overthrows this argument which hints that nutrition is accomplished by the nerves.

Electricity quickly brings on the menstrual flow, sometimes even whilst the patient is being electrified, and if this does not take place, slight *leucorrhœa* is first induced, and afterwards the menstrual flow breaks forth. This depends upon the same principles, that is, the electric fluid by accelerating the fluids in the smallest vessels and carrying them with it, enlarges the openings of the vessels of the womb so that the menstrual fluid flows out of them. Perhaps in some cases the electric fluid relieves the spasms both of the vessels and of the womb itself; but since we confess that we are altogether ignorant of the mechanism by which muscle is able to contract itself, we shall in vain endeavour to explain its action in relieving spasms.

In the same way the expulsion of calculi from the ureters is explained. It also removes baldness, by promoting the circulation of fluids through the glands which divide the hair, or the roots of the hair.

Having completed our observations upon the action of electricity in curing diseases, we must now speak of the diseases in which it has already been used with advantage, and of those in which our theory promises that it will bring relief in the future; and first,

ON FEVERS.

Electricity has cured Intermittent Fevers ;* Wesley got rid of tertian and quartan fevers, and† Lindhoult most obstinate quartan fever by the use of electricity. Intermittent fevers result from the energy of the brain being impaired and whatever supplies or restores tone to the system, stops the paroxysms, and removes the disease ; whence it seems probable that elec-

* 'The Desideratum.'

† "Notes upon Diseases cured by Electricity." See 'Med. Com.,' v. 1, p. 372.

tricity removes disease by promoting the circulation of fluids through the vessels of the brain and nerves, and so by renewing the nervous energy. Would it not in the same way remove all at once continued fevers, especially those called nervous fevers? *Insulation* at least might be safely applied in the case of these.

It has removed *Quinsey; in this case, indeed, it gave relief by a kind of local stimulus; for sparks were extracted from the neighbouring parts, and we know as a well ascertained fact, that stimuli applied to a part near to an inflammation, lessen the inflammation; but perhaps some relief resulted from the penetrating property of the electric fluid, for it spirited the disease away in the shortest space of time.

Chronic Rheumatism has received the greatest assistance from electricity. It seems reasonable to conclude from various phenomena of this disease that its proximate cause is a failure of the circulation in the smallest vessels and an irritability of these, together with a weakness of the larger vessels.

* Ferguson's 'Introd.,' p. 125.

And to show that this is a probable idea, let us consider the remote causes, the symptoms, the sequelæ, and the means of curing the disease.

It is generally allowed that the Remote Cause of Chronic Rheumatism is the excessive and overstrained action of the vessels in the part affected, which often happens in Acute Rheumatism or in sudden distortions of the joints or in contusions; a too long protracted strain upon the muscles, or violent exertions bring on weakness; and the weakness is often accompanied by irritability, especially after Inflammation.

The symptoms are *pallor* and *coldness* of the parts affected by the disease, which show that the circulation is weak; for the heat of the body is evidently closely connected with the circulation of the blood. A *dryness* of these parts, when the rest of the body is bathed in perspiration, shows that the blood is not sent into the smallest vessels. Stiffness of the *joints*, a creaking sound and pain, whenever the legs are moved indicate a want of synovial fluid or of the fluids which lubricate the joints. *Wasting of the limbs* depends upon the same cause (viz. a defective circulation in the smaller vessels).

The *sharp pains* by which invalids are tortured after a sudden change in the temperature or the density of the atmosphere show the irritability of the blood-vessels, which causes them to be distressed by an unusual distention or contraction.

The sequelæ are a fixed joint, or sometimes anchylosis, arising from the obliteration of the cartilages, and paralysis from collapse which arises from the causes already mentioned.

A cure is effected by medicines which in the first place, restore the tone of the system and thus do away with the irritability; such as Peruvian bark and cold baths. 2ndly, which promote the circulation of the blood through the veins and thus do away with the stiffness, &c.; among these are stimulants, friction which mechanically promotes the circulation of the fluids, and exercise. Hence we conclude that the electric fluid relieves Chronic Rheumatism by promoting the circulation of the blood through the enfeebled blood-vessels, and thus renewing the nervous and muscular force. Could not the *Pencils* be applied with advantage in acute rheumatism, especially after blood-letting?

Loss of reason sometimes follows Delirium, and seems to arise in some cases from the impairing of the circulation in the vessels of the brain which have been weakened by the preceding inflammation. In this case we may expect *a priori* that insulation may be of service by promoting the flow of the blood through the smaller vessels, and perhaps benefit may be derived from electric sparks or the pencils acting on the parts which are near to the brain.

PARALYSIS.

We have spoken elsewhere of the usefulness of electricity in this disease; and from what has already been said there is room to hope that electricity will be of service, if the paralysis is caused by collapse. De Haen,* who has made the greatest use of electricity pure and simple and also of insulation with the utmost care and perseverance, relates very many instances of success; five cases of paralysis being cured by electricity are related by Saunders,† cases which derived no benefit from other remedies, and Brydone‡ restored to health in three days a woman who had been affected with hemiplegia for six months.

* 'Ratio Medendi.' † 'Medical Commentaries,' vol. 3.
‡ Whytt's Works.

Dyspepsia confessedly arises from weakness of the muscles of the stomach and from impaired vital power and so it may possibly be relieved by electricity; insulation increases the secretions, and so it might help Digestion by increasing the quantity of the gastric juice. Since there is the closest connection between perspiration and the desire for food,* so that whatever increases the perspiration generally sharpens the appetite, we may say for certain that either simple electricity or insulation when it increases perspiration removes anorexia; and † l'Abbé Nollet, who applied electricity to young men for five hours at a stretch noticed that their appetites were sharpened; and Ferguson‡ cured pain in the stomach by electric shocks.

Since it promotes the menstrual discharge, perhaps it might prove of service even in Chlorosis.

Spasms are often relieved by the use of electricity; but since we have observed on a former

* 'Cullen's First Lines,' p. 33, Sydenham's Works, 125-6.
† Priestley, 'On Electricity,' 137. ‡ Introduction.

occasion that we are altogether ignorant of the mechanism by which the power of contraction is afforded to the muscles, we will bring forward only a few examples of spasms being relieved by electricity, and add one or two diseases, in which, *a priori*, we may expect benefit from the use of electricity.

TETANUS and TRISMUS deserve to be mentioned first among spasms, both on account of the danger with which they threaten the patient, and also on account of the obstinacy with which they withstand the most powerful remedies. Dr. Watson cured of tetanus a girl seven years old, and Dr. Spry of trismus another girl eighteen years old by electricity.

* De Haen often cured ST. VITUS' DANCE by electricity;† Lindhoult cured epilepsy, and ‡Wesley hysteria. Therefore I think it would be worth while to make trial of the powers of electricity in §SPASMODIC ASTHMA, in Whooping-cough, in Colic, and Hydrophobia.

* 'Ratio Medendi.' † 'Medical Commentaries,' vol. 1, 373.

‡ 'Desideratum.'

§ A woman who was suffering from an irregular attack of intermittent fever, was seized with asthma; the eminent Dr. Hope ordered electricity to be applied, which suddenly cured

Very many experiments show that electricity changes atmospheric air into fixed air, this arises from the phlogiston* of which it consists, or at least which it very largely contains: Hence it seems probable that it might be of the greatest service in the cure of Tympanites and Emphysema, by promoting the absorption of the air; for air seems to be absorbed through the lacteal glands only in the form of fixed air. Insulation or a lengthened application of the pencils promises relief in this case. Perhaps it might remove anasarca and be of service in rickets. It very often prevents† contraction by promoting the secretion of the lubricating and synovial fluids.

We have remarked before that AMENORRHŒA is very often overcome by the powers of electricity.

the asthma and brought on the cold stage of the intermittent fever. When the paroxysm was over the asthma again returned, and when it had a second time been driven away by the electricity, the paroxysm of intermittent fever returned. This was repeated in alternate succession several times. 'Edin. Infirmary Register,' 1771.

* A name formerly given to what was supposed to be pure fire fixed in combustible bodies.

† Lindhoult, 'Medical Commentaries,' vol. 3, 371. Jallabert, p. 7, 'On Electricity,' &c.

*Blindness, Toothache, Deafness, Cancer, and very many other diseases have been removed by electricity.

"Correctness' shade deceives us, in our aim
"To be concise, we grow obscure again:
"And he who strives great smoothness to acquire,
"May round his verses, but will lose their fire.
Horace, Ars Poetica.

* Hey mentions seven cases of patients being cured of amaurosis by the use of electricity. 'Lond. Med. Obs.,' vol. 5, pp. 1, 25.

THE END.

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